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Security of Explosives pan-European Specialists Network

D6.8
EXERTER 8th report on innovations, standardisation and exploitation within SoE

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EXERTER 8th report on innovations, standardisation and exploitation within SoE

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Summary

This deliverable on analysis and recommendations is the eighth of the 6-monthly series. It follows the structure outlined in EXERTER D6.1 that describes the yearly project cycle, the interaction between work packages, and the role of the Counter Attack Coordinators.

The report aims to produce tangible output useful for all Security of Explosives (SoE) stakeholders. The deliverable summarises and analyses the findings on innovations, standardisation, and exploitation related to this year's attack scenario: Criminal use of explosives. It provides the updated user requirements, based on discussions with practitioners and other stakeholders, and an analysis of the research and initiatives in standardisation and certification that are ongoing in the field. It also includes aspects of the issue presented and discussed during the annual conference.

In an annex to this public report is a summary of the achievements concerning the scenario. EXERTER will distribute this summary also to a broader audience interested and active in the field. There are also two separate annexes, one containing further details on the workshop on exploitation, which has the limited dissemination level CO, and one security classified EU-Restricted annex containing the outcomes from discussions on gaps and requirements.

Contents

1 Introduction

1.1 Background

EXERTER connects 20 practitioners from 13 EU member states and associated countries across Europe into a network of explosives specialists. The network aims at identifying and promoting innovative methodologies, tools, and technologies that will offer solutions in the fight against terrorism and serious crime, i.e. enhancing the Security of Explosives (SoE). The core of the EXERTER network brings together experts coming from Law Enforcement Agencies (LEA) and Military Institutes, Governmental and Civilian Research Institutes, Academia, and Standards Organisations.

The main objectives of EXERTER are as follows:

- Providing solutions to practitioners in the field by extrapolating terrorist threats and attack strategies from recent incidents and matching these with existing and emerging technologies and tools

- Ensuring the practice-relevance of R&D activities by defining end-user requirements and pinpointing existing capability gaps

- Supporting practitioners as well as academia, developers, and innovators in their search to find potential industrial partners who can exploit the innovations into products

- Enhancing practitioner's operability by supporting standardisation and certification bodies as well as regulators with standardisation and certification priorities to help comparison of SoE products and procurement

- Enabling long-term cooperation among explosives specialists in the security area beyond EXERTER

- Though being a self-sustaining network in terms of expertise, the goal of EXERTER is to expand and reach out to the entire Security of Explosives community. Moreover, to facilitate the interaction among end-users, industry, academia, and promote innovation and uptake.

EXERTER has established an End-user and Expert Community (EEC) that expands during the project to include relevant stakeholders. In addition, all dissemination activities include a broader network.

The project spreads results and outputs through yearly conferences, workshops, webinars, newsletters, and other interactive activities.

The project uses the yearly scenarios as a framework to highlight different aspects of the explosives threat and as a base to work with these aspects within research, innovation, standardisation, and exploitation.

EXERTER covers each yearly scenario with four counter-attack domains in mind: Prevent, Detect, Mitigate, and React (Figure 1). The counter-measures in these domains differ technically and operationally. Since users and stakeholders differ in these domains, EXERTER provides a broad scope for the network.
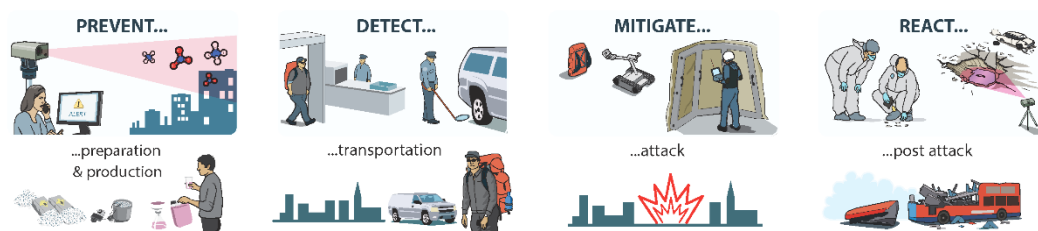

Figure 1: The counter attack domains addressed by EXERTER.

1.2 Objectives and scope of the report

This report is the eighth of the 6-monthly deliverables on analysis and recommendations in the EXERTER project. It aims to summarise and analyse requirements, innovations, standardisation, and exploitation related to the yearly set of scenario and present tangible results for the stakeholders.

This year's set of scenarios has had the theme "Criminal use of explosives". The scenarios, as a framework, highlight different aspects of the explosives threat, and within the project, EXERTER has worked with these aspects in research and innovation, standardisation and exploitation. Throughout the work, focus has been on all four counter-attack domains; Prevent, Detect, Mitigate, and React. The counter-measures in these domains differ technically and operationally, and since users and stakeholders differ in these domains, EXERTER provides a broad scope for the network.

This report presents the findings from the different areas in EXERTER related to the yearly set of scenarios and in more cross cutting fields such as standardisation and exploitation.

1.3 Outline of the report

This report starts with an overview of the last year's set of scenarios, and summarises the discussions about requirements, gaps, and procedures. It highlights relevant research projects and reviews material that EXERTER has used as input for the standardisation and certification work. It also describes the work performed to capture the product development in industry and by manufacturers; this allows getting their view on how different procedures are working and where there is room for improvement.

Furthermore, the content and outcome of the EXERTER annual conference is described, and the report concludes with an analysis and recommendations.

Three appendices provide further details as follows: Appendix 1 briefly describes related research projects, their funding and duration, and links to their respective webpage; appendix 2 technologies; and appendix 3 and provides comprehensive summarises of individual techniques in the form of one-pagers that indicate product type, overview of characteristics, application- and market aspects, and a cost-estimation.

In an annex to this public report is a summary of the achievements concerning the topic. EXERTER will distribute this summary also to a broader audience interested and active in the field. There are also two separate annexes, one containing further details on the workshop on exploitation, which has the limited dissemination level CO, and one security classified EU-Restricted annex containing the outcomes from discussions on gaps and requirements.

2   Scenario in brief

Each year, EXERTER focus the discussions, issues and suggestions around a set of scenarios, in order to keep the discussions focused and to find new challenges. The description of the 4th scenario scope is presented in summary in this chapter, including a few alterations considered in the discussions with stakeholders. The full version can be found in EXERTER D6.7.

The previous set of scenarios used have been on VBIEDs and HMEs (year 1), explosive attacks in public transport system (year 2), and person borne IED (year 3). Now, during the fourth year, the scenarios have had the theme criminal use of explosives.

The topic chosen for this year's workshop was very broad; it can be discussed from different views and perspectives. Several scenarios have been outlined where some parameters are varied (Figure 2), which allows for discussion where different problems and aspects can be highlighted. The common factor in the scenarios is the *illegal use of explosives* and the motive is *non-terrorism related*.
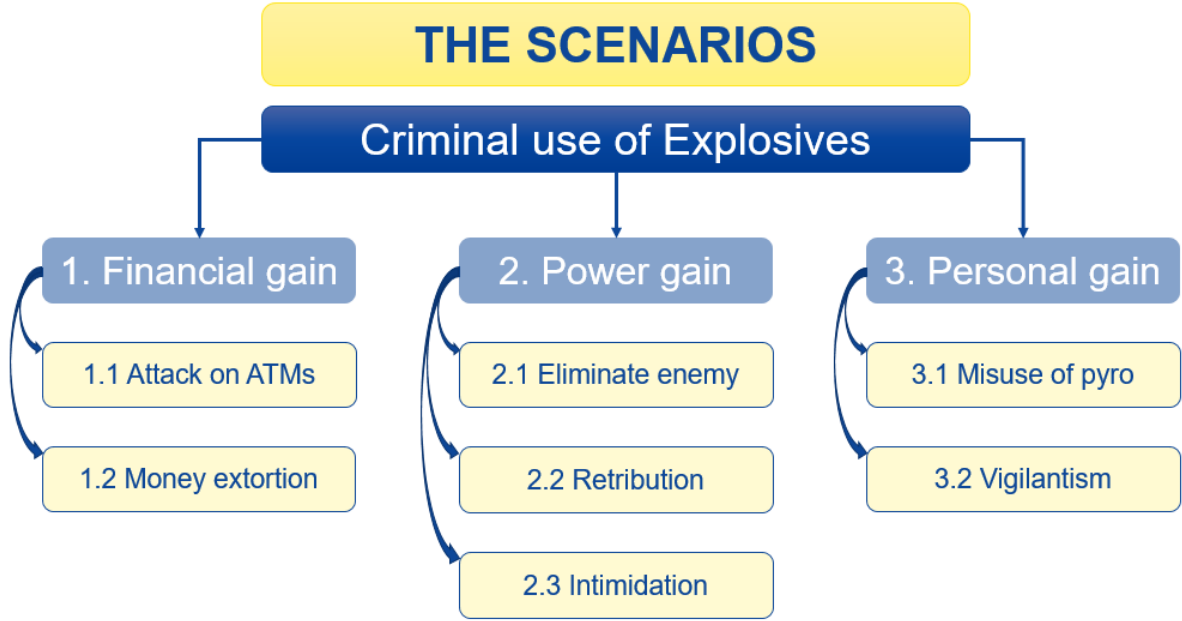

Figure 2: Overview of the scenario structure.

Further details are summarised in Table 1 and described in D6.7 EXERTER 7th report on innovations, standardisation and exploitation within SoE.

Table 1: Several parameters are varied in the different scenarios; they are summarized in the table below.

Scenario	Perpetrator	Motive	Target	Explosive type	Effects
Scenario 1: Criminal use of explosives for financial gain					
1.1 a)	Criminal gang	Access cash	ATM	IED; fertilisers, flash powder, TATP	Personal injury, damage to building
1.1 b)	Criminal gang	Extortion to access cash	ATM maintenance team	IED	Traumatized maintenance team
1.2 a)	Criminal	Money extortion	Shopkeeper	Hand grenade/ IED in a parcel	Destroyed shop
1.2 b)	Criminal gang	Money extortion	Local businesses	Pipe bomb; 'banger', shotgun propellant flakes	Fear
Scenario 2: Criminal use of explosives for power gain					
2.1	Gang member	Eliminate enemy	Gang enemy	Dynamite, blasting cap, black powder fuse	Casualties and injuries, damage of building
2.2	Organised crime group	Retribution	Small-time criminal	IED: pyrotechnics, petrol	Fragment injuries and burns
2.3	Criminal gang	Threat/ intimidation	Witness	Low level HME	Damage to building
Scenario 3: Criminal use of explosives for personal gain					
3.1	Football supporter	Have fun	—	Pyrotechnics	Fragment injuries and burns
3.2	Wood sales person	Intimidate thieves	Wood thieves	IED/HME/ Pyrotechnics	Personal injury/damage

2.1   Scenario description

2.1.1   Scenario 1 – Criminal use of explosives for financial gain

Scenario 1.1 Attack ATMs for cash
a) Robbers target automated teller machines (ATMs) with less stringent security systems to get money. The denotation lead to partial destruction of the ATM safe, with fragments reaching 200 meters, hitting a passer-by in the face.

b) Robbers kidnap two members of a maintenance team loading ATMs. They strap an IED to one of the victims and force him to open various ATMs in order to steal the cash.

Scenario 1.2 Money extortion
a) A small-time criminal tries to access money by extorting a shopkeeper. He/she places a hand grenade before/in a shop door with a note to; pay via Bitcoin a sum of "x" Euro "or else!".

b) A gang extorts local businesses for 'protection money'. One business owner refuses to pay. They extensively damage the owner's car by initiating a small pipe bomb and a banger.

2.1.2   Scenario 2 – Criminal use of explosives for power gain

Scenario 2.1 Eliminate enemy of the gang
To kill, harm, or scare an enemy that poses a threat to a gang, a person initiates an IED via a black powder fuse at the entrance of a residence building; the fuse generates a delay that allows the person to leave by car before the detonation.

Scenario 2.2 Retribution

A small-time criminal stole drugs from his gang to sell for his own profit. The gang places a timed blast incendiary at night on the windowsill of his bedroom window to injury or kill him and his partner, and to serious damage to his property.

Scenario 2.3 Intimidation of witness

There could be a similar scenario, in which the injured witness of the ATM-robbery in scenario *1.1a* or the kidnapped victims of scenario *1.1b* is the subject of intimidation by the member of the criminal group. This could involve the detonation of a low-level HME outside the house of the victims/witness, to warn them regarding the repercussions of revealing the criminals' identity.

2.1.3 Scenario 3 – Criminal use of explosives for personal gain

Scenario 3.1 Misuse of pyrotechnics for fun

A football supporter smuggles a few "innocent" flash-bangers into a football stadium and lights them. For some, pyrotechnics and flares are fan tradition. Some bangers land in the audience and cause injuries to bystanders; burns to the skin, damage of hearing and cuts due to fragments from the bangers.

Scenario 3.2 Vigilantism

An explosion in the wood oven of a cabin destroys the room and wounds residents. Investigation reveals a wood plank with a prepared pyrotechnic device in it, which detonated in the oven; it was prepared by a firewood salesperson to stop wood thieves in self-justice.

3 Identified requirements and gaps

3.1 Scenario discussions

In order to collect input on requirements, gaps and recommendations from practitioners and stakeholders, EXERTER normally holds a larger workshop where the scenarios are discussed and different alternative plots are explored. However, due to the lockdowns in most EU countries caused by the COVID-19 Pandemic it has been challenging to bring the groups together during the last two years. Instead, workshops have been held on national levels by each partner, to the extent possible in each country. Material (e.g., discussion points) were prepared, shared, and used as a framework for structured discussions.

The workshops typically started with a presentation of the scenarios, a selection of which scenarios to discuss, a discussion around the prepared discussion points, and in some cases the more specific questions on each country's organisation.

In this chapter, a publicly releasable extraction of the results from the national stakeholder workshops, contains requirements and recommendations for the fourth year set of scenarios, is included. The full version can be found in the EU-R classified Annex 3 to this report. The outcomes below are divided into PREVENT, DETECT, MITIGATE and REACT, and in each section a number of subsections are used in order to group similar requirements or suggestions together.

3.2 PREVENT

3.2.1 Access to commercial explosives

- To prevent the scenarios described, a straightforward approach would be to hinder access to the explosives. This includes theft of commercial explosives from construction sites and ammunition depots. Incidents should be investigated immediately in order to prevent the use of the explosives.

- Background checks on all employees who work with/have access to explosives within construction and mining businesses could decrease the risk of theft and illegal trade.

- Commercial (and military) explosives are sometimes accessed through import from other countries. A recommendation here could be to harmonize the border checkpoints of cargo that passes borders both within and from the outside of EU.

- Voluntarily return of the leftover guns and arms could reduce the availability.

- Education of the public on the danger and risk with explosives and precursors could increase awareness and perhaps reduce use.

3.2.2 Access to precursors and other material

- An unwanted effect from stricter regulations could be increased production of homemade explosives. The access to HME precursors is limited through EU regulations, which are continuously updated.

- Several recipes/instructions can be found on the internet on how to make different types of charges. Increased surveillance on open sources (social media etc.) is possible, but also resource demanding. It may also need legal clarifications regarding storing and handling of mass data.

- Stricter regulations for access to explosives could help counter the problem, and supervision should be carried out. This includes also regular checks of those who have access to explosives.

- An all hazards approach, covering other possible precursors than the specific chemicals in the EU-regulation, could also be used with the aim to avoid missing new combinations etc.

3.2.3 Access to pyrotechnics

- The legislation around pyrotechnics varies between member states. Information on the danger and risk with pyrotechnics could be highlighted to legislators, manufacturers and the public. For example, cases where pyrotechnics have been used in acts of violence to cause harm can be used, and reports on the possible damages caused.

- Better control of pyrotechnics allowed to be sold legally could reduce misuse.

3.2.4 Harmonized legislation around pyrotechnics

- Smuggling within EU is an issue, due to different legislation between EU member states. This might be limited by harmonized EU regulations regarding what type of products that can be used legally with a permit.

- Regarding the criminal denotation there is in some countries today little or no difference in the penalty for possessing large vs small firecrackers, although the former can do much more harm than the latter.

- Some ideas for improving the situation can be to regulate/limit the size of pyrotechnics, and that the punishment for use/possession should reflect the possible damage that could be caused.

3.2.5 Facilitate the process that leads to conviction

- The process of prosecution could benefit from increased education to lawyers and prosecutors on how to use legislation to convict in cases involving explosives.

- An easy process to use expert advice from explosives specialists and chemists, and cooperation between organisations/authorities also simplifies and speeds up the process.

3.2.6 Information sharing and communication

- Inter-institutional communication and exchange of information is important in understanding and fighting the crime. The same is important between and within the civil and military sector.

- Facilitated inter-institutional procedures simplifies information sharing, and does not depend on personal contacts. As for sharing of the information on an international level, seminars and educations are used.

- Shared networks between civilian and military side could give increased value, and include things such as common training programs.

3.3 DETECT

3.3.1 Possibilities for detection prior to the explosion

- Some recommendations in order to detect the threats are surveillance cameras at construction sites, which could help identify theft of explosives, or improved control of employed personnel.

3.3.2 Tips from common citizens

- Information the general public on typical signs that indicates an illegal business or an HME lab could increase warnings. There could also be an anonymous number for reporting of suspicious behaviour.

3.3.3 Access to training

- It is important to include new trends and threats in the training, and make sure all levels at the police are included.

3.4 MITIGATE

Mitigating the effects of an explosion is widely established for critical infrastructures and sensitive buildings with an increased protection level demand. Most commonly, these mitigation options include increased stand-off distances (using physical measures such as pollards), the usage of hardened building components and architectural and design rules that, e.g. facilitate the evacuation of people during an attack. However, there is a common understanding that these well-established measures are not applicable to residential buildings and private houses due to their high costs, in contrast to the low probability of an attack (in correspondence to this year's scenario) will occur in front of or inside a residential building and as such are economically not feasible. Even ATMs and the environment of ATMs are typically not designed to mitigate explosion effects due to cost-benefit reasons. As such, effective measures and potential further research initiatives with respect to the current scenario are more relevant for the Prevent, Detect and React Counter Attack phases rather than for the mitigate phase itself.

3.5 REACT

3.5.1 Evolve forensic work

- It is important to carry out forensic investigations and secure evidence. Fingerprints, DNA and fragments from the explosion must be collected. Samples must be collected to analyse explosive residues.

- Increased public awareness on the importance of not going near a crime scene post blast, and further education of rescue services and police on how to work around the crime scene without contaminating the site or destroying any possible evidence, could be suggested.

- Improved cooperation and communication between authorities that work at a crime scene post blast; forensic investigators, police, rescue services, explosive specialists etc. could facilitate the work.

3.5.2 Technical forensics

- Taggants in commercial explosives is a way of tracking the source.

3.6 Identified requirements and gaps

The identified requirements and gaps are provided in an EU Restricted annex, Annex 3, to this report. It contains the input received from stakeholders concerning requirements and gaps connected to Security of Explosives capabilities, gathered in the discussions. A preliminary list of practitioners' requirements and needs in the context of this scenario was included already in EXERTER D6.7 Annex 2. In this report, this list has been updated, finalised, and analysed.

Practitioners' ideas and knowledge on requirements and gaps have supported the continued work in EXERTER.

4 Research review

4.1 Introduction

Within EXERTER, an overview of research projects is made, identifying completed and ongoing national, European, and international Security of Explosives (SoE) projects that can help in the fight against terrorist attacks. Relevant research projects are screened with the aim of finding solutions to user needs and closing gaps.

Each year, projects related to the set of scenarios are identified. They are further studied in each of the four counter-attack domains PREVENT, DETECT, MITIGATE and REACT in order to identify relevant solutions or needs for further research.

4.2 Progress and Results

4.2.1 Overview of SoE research activities

Using information from other projects, such as NDE, HECTOS, ERNCIP and other publicly available summaries (e.g., website of the projects, CORDIS search, and databases), an overview of SoE research activities was compiled in the form of an Excel spreadsheet (see appendices at the end of this document). This includes projects funded by the EU, NATO, EDA, or national organisations. The relevant characteristics included in the overview were defined as follows:

- Project/publication short name
- Project full name, publication title etc.
- Grant
- Topic/summary
- Project duration
- Website
- Relevance - Counter Attack Phases
- Relevance to the scenarios of years 1, 2, 3 and 4
- Developed Tools: Categories
- Developed Tools: Description
- EXERTER-partners involved
- Comments

Missing information on existing entries has been added and the table has been expanded and currently contains 262 projects. As intended, the work is in an ongoing cycle of screening the current status of international projects through communication and interaction with other projects as well as through web research, workshops and conferences. The summary table is updated as new projects or new information on existing entries are received. The table contains only unclassified information. In addition to traditional research activities, two banking sector documents were included in the table as they provide valuable information about ATM security.

4.2.2 Review of activities in the different attack-phases

From the extended review of research projects, promising research activities that can address existing user needs and close gaps in the respective scenario were selected. The year four set of scenarios address criminal use of explosives. As before, the research projects were selected for each of the four phases of a terrorist attack, PREVENT, DETECT, MITIGATE and REACT.

For the year 4 scenarios, the following projects were selected.

4.2.2.1 Task 3.3 PREVENT

For the PREVENT phase following projects were selected:

- CAPER (Collaborative information, Acquisition, Processing, Exploitation and Reporting for the prevention of organised crime) The goal of the CAPER project was to create a common platform for the prevention of organised crime through sharing, exploitation and analysis of Open, and optionally, Closed information sources. CAPER supported collaborative multilingual analysis of audio-visual content (video, audio, speech and images) and biometrics information, supported by Visual Analytics and Data Mining technologies.

- SAFEPOST (Reuse and development of Security Knowledge assets for international postal supply chains) SAFEPOST aimed to raise the current level of postal security by integrating innovative screening solutions suitable for uninterrupted flow of the enormous volumes of parcels and letters with operational postal processes and the criminal and customs intelligence work in a European wide cooperative distributed model.

- TAKEDOWN (Understand the Dimensions of Organised Crime and Terrorist Networks for Developing Effective and Efficient Security Solutions for First-line-practitioners and Professionals) Organized Crime and Terrorist Networks (OC/TN) are a major challenge for the European Union and many different stakeholder groups are involved in creating awareness, preventing, identifying and intervene in case of risk or threat. But in order to develop better strategies and instruments, we still need a deeper understanding of these phenomena. TAKEDOWN therefore aimed at generating such novel insights on OC/TN. In order to meet this challenge and to investigate this complex field of research a multidimensional modelling approach was used. The resulting, proprietary TAKEDOWN Model described social, psychological, economic aspects as well as further dimensions, activities and response approaches.

- INSPEC2T (Inspiring CitizeNS Participation for Enhanced Community PoliCing AcTions) INSPEC2T projects' scope was to develop a sustainable framework for Community Policing that effectively addresses and promotes seamless collaboration between the police and the community.

- UNITY Unity aimed to create a new, community-centred approach to Community Policing: developing new tools, procedures and technologies, putting people at the heart of identifying policing priorities and ensuring citizens are an integral part of informing sustainable solutions.

- SMARTPREVENT (Smart Video-Surveillance System to Detect and Prevent Local Crimes in Urban Areas) The SmartPrevent project aimed to enhance detection and prevention of crimes in local urban areas by exploiting the full potential of video-surveillance systems.

- VALCRI (Visual Analytics for sense-making in CRIminal intelligence analysis) The purpose of Project VALCRI was to create a Visual Analytics-based sense-making capability for criminal intelligence analysis by developing and integrating a number of technologies into a coherent working environment for the analyst we call the Reasoning Workspace.

- VICTORIA (Video analysis for Investigation of Criminal and TerrORIst Activities) Video recordings have become a major resource for legal investigations. Since no mature video investigation tools are available and trusted by LEAs, investigators still need to carry out the analysis of videos almost exclusively manually. Current practices are too resource intensive to handle the yet huge and steadily increasing volume of videos that need to be analysed after crimes and terrorist acts. The consequence is that LEAs cannot analyse all available videos because of the huge effort needed, and the extraction of first clues from videos after a terrorist attack takes more time. VICTORIA addressed this need and delivered a Video Analysis Platform (VAP) that accelerate video analysis tasks by a factor of 15 to 100 (depending on the use case), while providing very reliable results.

4.2.2.2 Task 3.4 DETECT

For the DETECT phase, the following projects and some detection equipment and systems were investigated:

- AWARE (Advanced Face Recognition and CroWd Behavior Analysis for Next GeneRation VidEo Surveillance). The AWARE project proposed an innovative solution that analyses crowd behaviour, achieves high processing speed, and is cost-effective.

- VICTORIA (See 4.2.2.1)

- ERNCIP VIDEO Video Surveillance for Security of Critical Infrastructure
  https://erncip-project.jrc.ec.europa.eu/networks/tgs/video

- Best Practices for Preventing ATM Gas and Explosive Attacks: Trained staff who perform real time monitoring of building alarms and CCTV covering the area around the ATM and the interior of the room housing the ATM can provide an early warning that an attack is about to be perpetrated. Alarm grids such as penetration mats attached to the inside of the fascia and the rear of the dispenser and depository shutters can provide an early indication that the ATM is being attacked prior to the insertion of explosives. Monitoring shutter opening events that are not controlled by the ATM application can also provide an early indication that the ATM is being attacked by forcing the shutter to open. Gas detectors fitted within the security enclosure can provide an alarm or activate a neutralization system for explosive gas attacks where gas is inserted directly. Deployers can monitor the network for card numbers used to initiate an attack by opening shutters via a transaction.
  https://www.atmia.com/files/Best%20Practices/Preventing%20Gas%20and%20Explosive%20Attacks%20%E2%80%93%20Version%202.pdf

- Recommended Physical ATM Security Guidelines: Solid explosives are harder to detect. The speed of the explosion makes it more difficult to prevent. Therefore, enhanced physical protection should be considered.
  https://www.link.co.uk/media/1181/best-practice-for-physical-atm-security.pdf

- CoESS (Certification of EDDs) CoESS is part of an EU-funded project consortium to raise quality in Explosive Detection Dog (EDD) services.
  https://www.coess.org/projects-and-standards.php?page=certification-of-edds

- ERNCIP DEWSL Detection of Explosives and Weapons in Secure Locations

- EU Guidance on Operating for Explosive Detection Dogs in Public Spaces: Public and private operators of public events where, due to security reasons, EDD may be considered for security operations, should receive extracts from this guidance in order to understand the key principles on the use of explosive detection dogs. The guidance could be used to establish programme outlines, specific memo-cards, operational guidance and other aids for management, dog handlers and other staff involved in EDD operations.
  https://ec.europa.eu/newsroom/pps/document.cfm?doc_id=71619

- IDT will be an industrially manufactured product invented by TSE and it is the only system on the market allowing automated 24/7 behavioural testing of 5-10 dogs in a home-cage setting. IDT will train dogs, will support certification and re-certification and will result in high performing dogs at large scale.

- CHEQUERS (Compact High pErformance QUantum cascadE laseR Sensors) CHEQUERS developed two devices. The first was be a tripod-mounted device which utilises a very high-finesse broadly tunable ring-resonator QCL coupled with a raster scanning imaging head with high backscattered radiation collection capability. The second device addressed the urgent requirement for highly portable low-cost detection hardware.

- MiRTLE (Next generation, high performance, long range, standoff, concealed threat detection system to protect European citizens and critical infrastructure) Radio Physics Solutions Ltd has developed MiRTLE (Millimetre-wave Radar Threat Level Evaluation), the world's first, high performance, long range (up to 50 m), low cost, standoff "concealed threat" detection system for the protection of citizens and critical infrastructure. MiRTLE is capable of screening large groups of people automatically and autonomously, without operator intervention, in real-time. The highly

innovative system detects PBIEDs, guns (including 3D printed) and knives up to a range of 50m in real-time, with targets in motion, all without privacy concerns. The overall objective of this project was to successfully refine, scale-up, and demonstrate the technology to the customer base.

- STANDEX (Stand-off Detection of Explosives) In 2009, the NATO-Russia Council launched a project for the Stand-Off Detection of Explosives (STANDEX) on suicide bombers in mass transport. This project, which is supported by the NATO Science for Peace and Security Programme, developed technologies to detect explosives concealed on a person moving through a crowd, for example in a metro station at rush hour. At the same time, the detection efforts must cause minimal inconvenience to the large numbers of people who depend on mass transport in their daily lives.

- DEXTER EXTRAS (Detection of Explosives and firearms to counter TERrorism - EXplosiveTRacedetection for Standex) The project, funded by NATO's Science for Peace and Security (SPS) Programme, used laser spectroscopy to identify explosive materials on potential bombers. The project was part of a NATO initiative to develop a system capable of detecting explosives and concealed weapons in real time and securing mass transport infrastructure, such as airports and metro and railway stations.

- DEXTER INSTEAD (Detection of Explosives and firearms to counter TERrorism - INtegratedSystem for Threats EArlyDetection) aimed to develop a system to detect explosives and firearms in public spaces, remotely and in real time, without disrupting the flow of passengers.

- DEXTER MIC (Detection of Explosives and firearms to counter TERrorism - Microwave Imaging Curtain) The first project in this initiative brought together experts from France (ONERA, the Office National d'Etudes et de Recherches Aérospatiales), Ukraine (the Usikov Institute for Radiophysics and Electronics at the National Academy of Sciences), and South Korea (the Seoul National University) to design and develop a microwave imaging system (3D). The goal was to detect explosives and concealed weapons in real time and will help secure mass transport infrastructures, such as airports, metro and railway stations.

4.2.2.3   Task 3.5 MITIGATE

For the MITIGATE phase following projects were selected:

- RIBS (Resilient Infrastructure and building security) The RIBS-project supported the design of effective and viable integrated security measures aimed at protecting infrastructures without impacting on their business dynamics. In a global context where national interests are increasingly interrelated, the most vulnerable infrastructures in Europe, and particularly the most critical ones, are primary targets for terrorists. Attacks, carried out under a national, political, or religious banner, now strike regularly in our cities, causing deaths, damage and disruption on an unprecedented scale. In the past seven years alone, 1300 terrorist incidents have taken place on European soil. The RIBS project aimed to deliver more effective and viable security measures by supporting a design process that integrates a broader understanding of the environment (and the contextual factors such as human elements) within which these measures are meant to be implemented. The particular objectives of the project included a set of functional and non-functional requirements that drive an effective security system design process, a set of protection measurement techniques that can be used to assess the level of protection offered by candidate security products proposed to be implemented in buildings and infrastructures. This work was carried out for a range of security systems aimed at securing buildings against hostile reconnaissance, intruders and hazardous attack (including chemical, biological, and explosive).

- VITRUV (Vulnerability Identification Tools for Resilience Enhancements of Urban Environments) All levels (concept, plan and detail) contributed to enabling the development of more robust and resilient space in the field of urban (re)planning/(re)design/(re)engineering. Planners who use VITRUV's tools are able to deliver urban space less prone to and less affected by attacks and disasters, thus sustainably improving the security of citizens.
https://cordis.europa.eu/project/rcn/98970_de.html

- SPIRIT (Safety and Protection of built Infrastructure to Resist Integral Threats) Thanks to the EU-funded SPIRIT project, researchers developed tools to reduce damage, destruction, and disruption to large new and existing buildings. A risk assessment was carried out to demonstrate how susceptible a building is to attack. This led to tools for designers and builders to measure and categorise vulnerability, as well as to identify efficient and cost-effective mitigation strategies. The partners compiled an extensive database of CBRE protective security and safety products like resistant window systems, a retrofit system for walls, explosion-resistant columns, and detection, and filtration systems for use by the European Commission, governments and related stakeholders. The database includes product effectiveness, cost, and improvement.

  All project outcomes were integrated into a comprehensive, software-based risk assessment tool developed by the researchers. This tool first defines the dimension, layout, and structural components of a multi-storey building, followed by the CBRE scenario. The data enables users to estimate the risks and aftermath of CBRE attacks on a building.

  The SPIRIT tool provides risk measures for structural damage, casualties, and economic loss. This data can be used for such countermeasures as structural enhancements, evacuation, and air quality management.

  SPIRIT has designed solutions to keep people who occupy large modern buildings as safe as possible. By introducing safety-based engineering and CBRE protection for public or private infrastructure, the project outcomes are slated to revolutionise building security.

- SUBCOP (Suicide Bomber Counteraction and Prevention) SUBCOP developed technologies and procedures that can be applied by the Police Security Forces when responding to a suspected PBIED (Person Borne Improvised Explosive Device).

- ENCOUNTER (Explosive Neutralisation and Mitigation Countermeasures for IEDs in Urban/Civil Environment) The objective of the ENCOUNTER project was to identify, explore and validate innovative techniques for mitigation and neutralisation of IEDs in urban/civil environment, which were summarised in a recommendation matrix and included a software tool to assist clearing forces

- Best Practices for Preventing ATM Gas and Explosive Attacks (see above)

- Recommended Physical ATM Security Guidelines (see above)

4.2.2.4   Task 3.6 REACT

For the REACT phase, following projects were selected:

- ADVISE (GES 3D Advanced Video Surveillance archives search Engine for security applications) ADVISE aimed to design and develop a unification framework for surveillance-footage archive systems, in an effort to deal with the increasingly critical need to provide automated and smart surveillance solutions.

- MisPel (Multi-biometric forensic person searches in large image and video databases) The goal of the MisPel project was to develop a software solution that helps investigators identify quickly individuals of relevance to their cases. The legal research being conducted on the project was concentrating on analysing the legal requirements that have to be met in order for data to be captured, filtered, and forwarded as well as assessing the extent to which evaluated image data can be used in court. The plan was to formulate a suitable, integrated data protection and security strategy. The social science research being done was therefore designed to deliver example criteria for privacy protection plus strategies for long-term deployment scenarios.

- FLORIDA (Flexible, semi-automated video forensics system for the analysis of mass video data) This bilateral German-Austrian project created a system for visual and auditory analysis of mass image and video data. The aim was to make it possible to reconstruct the sequence of events more quickly and spot potential suspects promptly.

- VICTORIA (See 4.2.2.1)

- FORLAB (Forensic Laboratory for in-situ evidence analysis in a post blast scenario) FORLAB´s goal was to deliver a novel systematic methodology for optimizing the evidence collection. The key innovation was the establishment and maintenance of a dynamic, real-time self-adaptable feedback loop between the data collection process at explosion scene and the data repository, with the aim of reducing the number of collected samples, improving the capability to recreate the scenario, and fine-tuning the screening process.

- PyroProf (Chemical Profiling of Inorganic and Pyrotechnic Explosives) The main research objective of the PyroProf project was to offer suitable analytical tools for the chemical profiling of inorganic explosives of forensic interest (e.g., ammonium nitrate based and pyrotechnic mixtures) for their use in forensic casework. This project yielded selective sampling strategies, novel separation methodologies by state-of-the-art CE-MS and IC-MS instruments, complementary statistical approaches and databases with further knowledge on explosive, precursor, and background compositions useful for forensic interpretation.

- 3D Forensics (Mobile high-resolution 3D-Scanner and 3D data analysis for forensic evidence) The 3D-Forensics system is a mobile high-resolution 3D-Scanner and 3D data analysis software to record and analyse footwear and tyre impressions as well as profiles left at crime scenes in 3D and colour with optical scanning technology.

- AUGGMED (Automated Serious Game Scenario Generator for Mixed Reality Training) The aim of AUGGMED was to develop a serious game platform to enable single- and team-based training of end-users with different level of expertise from different organisations responding to terrorist and organised crime threats.

- EVA (Risks associated with major public events – Planning, assessment, EVAcuation and rescue concepts) The interdisciplinary team on this project aimed to develop strategies for planning, assessing, evacuating and rescuing people at large events (e.g. football matches and the arrival of fans at stations) and to validate those strategies using simulation.

- FEXIN (Forensic Explosives Intelligence) The FEXIN project had three main themes: chemical profiling of illegal firework; impurity profiling to unravel synthesis conditions and raw material use; and explosive residue analysis in forensic traces.

- BONAS (Bomb factory detection by Networks of Advanced Sensors) The aim of this project was to develop a system for detecting ongoing illicit production of explosives and improvised explosive devices (IEDs) in urban areas. The goal of BONAS was to design, develop, and test a novel wireless sensors network for increasing citizen protection against terrorist attacks, in particular against the threat posed by IED devices.

The projects, studies and methodologies were studied in detail. For this purpose, summaries and other documents were requested and analysed among the EXERTER partners. Due to the wide number and the nature of the selected scenarios, there is not a study available for every scenario and Counter attack phase combination:

Table 2: Number of selected research activities for each scenario in each Counter Attack Phase year 4.

Scenario	PREVENT	DETECT	MITIGATE	REACT
1.1 Attack on ATM	4	5	6	5
1.2 Money Extortion	6	3	X	1
2.1 Eliminate Enemy	X	X	X	1
2.2 Retribution	X	X	X	1
2.3 Intimidation	5	X	X	1
3.1 Misuse of pyro	X	13	1	5
3.2 Vigilantism	4	X	X	X

The results were analysed and presented at the EXERTER Virtual Conference, Wednesday, 6th April 2022.

By actively engaging ongoing research initiatives and connecting them with manufacturers and other stakeholders, potential solutions to existing user needs can be brought to the table. New contacts can be invited and included in the EXERTER end-user and expert community (EEC) as appropriate.

5 Exploitation support

5.1 Introduction and overview

Technology and tools are central in countering the terror threat and bridging the practitioners' gaps and requirements. Thus, EXERTER works with finding appropriate state-of-the-art technology in the field of SoE, and focuses on supporting collaboration and interaction between different actors to improve exploitation possibilities.

Supporting collaboration and exploitation in the SoE field across Europe is achieved through creating a link between academia, industry, researchers, and end users. These links will help to exploit new research and facilitate the process of taking final steps towards commercialization (Researcher vs. End-user needs vs. Industry vs. Academia).

5.2 Market screening and state-of-the-art technologies

The EXERTER consortium has organised an online workshop on December 1ˢᵗ, 2021, entitled "From the lab to the client", with the purpose of bringing together all the actors in the European Security R&I ecosystem to share their experiences in turning their innovations into successful products and to analyse possible ways to improve the SRI cycle. The event was moderated by INTA, and it is the second in a series of interactive workshops around market uptake, standardisation and similar issues with an impact on strengthening SRI (Security Research and Innovation). The first one was moderated by TNO and took place on October 4ᵗʰ 2021. It dealt with standardization of innovations.

Here, a selection of the available material is shown; for the full content refer to D6.8 Annex 2.

5.3 Purpose of the Workshop

The EXERTER consortium has organised an online workshop on December 1st, titled "From the lab to the client", with the purpose of bringing together all the actors in the European Security R&I ecosystem to share their experiences in turning their innovations into successful products and to analyse possible ways to improve the SRI cycle (Security Research and Innovation). The event was moderated by INTA, and it is the second in a series of interactive workshops around market uptake, standardisation, and similar issues with an impact on strengthening SRI. The first one was moderated by TNO and took place on October 4ᵗʰ 2021. It dealt with standardization of innovations.

We also had a Discussion Panel and Open Debate section focussed on innovation business models, ways to improve cooperation and further actions that our regulators could undertake to make Europe more attractive for cutting-edge companies. It shared a common ground with the previous EXERTER online workshop, but it covered the whole innovation cycle from the inception of something new until it turns into a successful product in the market. It took into account our current business environment, where EU's research and innovation programmes are actually a game changer in strengthening European security and keeping us competitive in the current world stage by supporting industry and innovations.

The workshop had speakers from different European law enforcement bodies, SoE companies, academia, and R&D centres. Speakers from the European Commission, CDTI (Spain), PSNI (Ireland), DSTL (UK), FOI (Sweden), INTA (Spain), TNO (Nederland), CDTI (Spain), EOS (Nederland), TSD (Spain), Rohde-Schwarz (Germany), Iturri (Spain), and TEAM (Spain).

5.4 First section: Setting the Scene

5.4.1 Innovation for civil Security

The SSRI Policy Area Coordinator of the European Commission described the positive impact of 14 years of EU-funded SRI projects encompassing disaster risk reduction, border security, infrastructure protection, and fight against crime and terrorism, that allocated 3 billion euros to more than 600 projects.

Many factors hinder the adoption of innovation (e.g., very fragmented market, low market visibility, cultural barriers on the demand side, and ethical and legal societal issues). Innovation uptake is a slow process full of decisions, usually taken by the buyers, who steer the demand driven market. To succeed needs have to be understood from the beginning and users and suppliers need to collaborate.

The European Commission is trying to assist with policy actions, funding, and creation of knowledge. On the policy actions, they are making an effort to convey that SRI is a strategic priority. The concept SSRI (Strengthened Security R&I) marks a new destination that summarizes this new approach to pave the way from research to operations by creating a favourable environment to generate specific knowledge, to foster structure dialogue, and coordinated action among market actors.

5.4.2 Business and economics of the SoE industry

A propulsion engineer and expert in Security of Explosives in the EXERTER team of INTA, highlighted key concepts related to business strategy and shared tips on how to put together an innovative strategic plan starting with a reliable assessment of the environment. He also illustrated an environment analysis technique based on two pillars, "Check the facts and do the math", with a practical Strategic Assessment Case.

He explained the role of innovation in the strategic planning of a company; it is the responsibility of the senior management of every company to find a balance between milking the "cash cow" and developing a new star product. Business-as-usual keeps short and medium term profits but can produce a lack of competitiveness in the long term. Innovation enlarges our portfolio, footprint, income, and market share and puts us in a better position to fight terrorism, but it increases our entrepreneurial risk and can cause financial stress in the short term.

5.4.3 The importance of supporting industry and innovations in SoE

In his presentation, the managing director at PointFWD, who is also a leading expert in aviation Security, Airport Logistics & Applied Technology concluded that experience proves that we should start getting momentum at the early assessment of the new technology rather than waiting to have a working prototype or a technology demonstrator. Doing so, the industry gets some certainty or insurance on the existence of a real place for the future product in the market and the interest of the big investment. That certainty encourages the development team to continue to develop it and spin it up. Most successful stories come from gathering partnerships early in their development stage.

Not only government initiatives (i.e., public funding or new legislation) are required for innovations that are successful in the long run. A successful future in the market depends on a real involvement, commitment, and partnership of potential clients in the security industry from the beginning. We need proactivity to collaborate and partner with innovators on the side of the end users of the technology, including constructors, transport organizations, aviation industry, infrastructure protection providers, police, and law enforcement.

5.4.4 Public funding of innovation

The Horizon Europe Programme Officer of CDTI (Spanish Office of Science and Technology) in Brussels presented Opportunities on Public Funding of Innovation in Cluster-3 of Horizon Europe. Complementary to the presentation summarised above, under "Innovation for civil Security", it focused on the specific opportunities for enterprises on cluster 3, though there are also opportunities in Pillar III in the European Innovation council and the European Institute of Innovation & Technology.

5.4.5 The clout of the client

The Laboratory Manager in the Department of Physical Sciences of the Defence Science and Technology Laboratory (DSTL) of the UK illustrated the influence of the client on the innovation cycle in the Security of Explosives industry.

He stated that client and laboratory have responsibilities and influence in the innovation cycle; the role of the client is defining clear requirements, making changes of scope, enforcing terms and conditions,

and evaluating the quality of the laboratory. The role of the laboratory or research centre is producing honest reporting, pushing on, suggesting and advising options or change of scope, keeping the client informed of future progress for KPIs and bearing in mind that a final delivery is not enough to reach excellence.

He stated that further developments, spin-outs, and seeking funds is always implicit in any research that wants to push the boundaries of technology, and this is more on the side of the laboratory than on the side of the client. The key of success in this process is always a good communication between all actors, at least between the laboratory and the client.

The presentation used a real case based on the development of an innovative fluorescent simulant to determine the best location to swab a shoe that is supposed to carry concealed explosives.

5.5 Second section: Real Cases exemplifying successful stories

5.5.1 Mesmerise Project (Management of European Union funded SoE projects)

The Horizon 2020-funded Mesmerise Project was used as an example of how the funding from the European Commission can be the key of a successful innovation. The objective of Mesmerise (Multi-Energy High Resolution Modular Scan System for Internal and External Concealed Commodities) is the development of an enhanced non-intrusive (stand-off) scanner to detect commodities in human body cavities and behind the clothes. Current technologies (e.g., backscatter, millimetre wave body scan, metal detector, and transmission X-ray body scanner) need to improve their efficiency and reliability; they also need to respect privacy rights.

5.5.2 Vehicles' Protections (Technological Environment Case)

Luis Mariano Alcázar described how recent innovations in armour materials and protections allowed his company, Technology and Security Developments (TSD), to develop a new generation of lighter and better-protected vehicles.

Their division of mobile security currently produce different armoured vehicles for civilians, armed forces (police and army) and cash in transit. They also produce tactical multipurpose vehicles for the armed forces, including antiriot and prisoner transport trucks and vans. In these cases, the extensive use of new light armoured materials in combination with steel makes possible a reduction of weigh up to 70 %, which enables the production of reliable high performance armed vehicles that can defeat, for example ballistic threats, threats from mine blasts and IEDs.

5.5.3 Protection of infrastructures (Legal Environment case)

The CEO of TEAM (Technical Engineering, Advisors, and Management) presented a legal environment case titled "Protection of Infrastructures" to share the experience of designers and manufacturers of blast resistant doors and windows and to focus on challenges (mainly regulatory) that his industry faces today.

The knowledge gap between prime construction contractors and critical facility owners can concern legal requirements, standards, or codes for casualty prevention, and damage mitigation in case of a blast.

5.5.4 Personal protections (Legal Environment case)

The Sales Director of the Defence Business Unit of Iturri used their development of a combat uniform with blast protection as a business case that illustrates the necessity of having appropriate legislation that provides a safe environment in which different actors can cooperate efficiently.

The business case covered development of a new blast test that evaluates the effects of pressure wave and the projection of fragments, on the soldier equipped with their new blast-proof combat uniform.

5.5.5 Screening and detection technology (Economic Environment case)

The CEO of Rohde-Schwarz and their director of business development presented ways to bring innovation in personnel screening on the market; they also showed influences of economic environment.

Rohde-Schwarz developed a 360° walk-through security scanner for fast, touchless screening. The system operates with extreme low output power in the wide-band frequency range, providing excellent penetration of multiple layers of clothing. People can walk through the system at natural walking speed and posture because it is equipped with an AI-based detection software that can automatically identify objects. Visible areas like hands can be masked so that hand-carried items do not produce an alarm.

The future of the technology, currently used for loss prevention, VIP security, entertainment, customs, and border crossing, is unstructured-crowd screening for a volumetric group detection.

5.5.6 Facial recognition in a global environment (Social Environment case)

A researcher in Behavioural Science, Information Systems and Computer Graphics at TNO, presented a case that dealt with the influence of the social environment.

In modern democratic societies, privacy and the freedom of movement are fundamental rights that must be observed by all actors all the time. In Security of Explosives, either when screening in search for suspicious substances or when checking the complexion or the facial features of a person, all those principles must guide our proceedings.

The project of facial recognition in a global environment deals with those social environment constrains, and tries to check the features of the target population in the most efficient and least intrusive way taking into account all social factors from ethnic diversity to daily habits and social behaviour.

5.6 Conclusions

Collaboration at different stages and between different actors (e.g., governments, regulators, policy makers, industry, innovators, researcher teams, users) is essential to accelerate innovation. Governments and the European Commission should enable the creation of environments that stimulate collaboration with minimal bureaucracy that can slow innovation.

Smart standardization can level the playfield and avoid situations where compulsory compliance with certain requirements can stop innovation during its inception. Standards, certificates, and requirements are needed, but also enough flexibility to decrease pressure at the beginning and increase it when the idea is mature enough to cope with it.

The protection of buildings against blasts and terrorist threats should be part of the education of architects, construction-, and mechanical engineers.

While Europe should strive to maintain its values and way of making business, legislators should address potential weaknesses before competitors such as the USA and China.

The creation of an eco-system that includes all stakeholders could accelerate innovations in Security of Explosives. That ecosystem should comply with certain rules and guarantee beyond our current intellectual property tools that innovators keep the ownership and exploitation rights of their own innovations. A way should be found to open our ecosystems to companies outside the European Union when certain pieces of the innovation puzzle can only be found beyond our borders.

5.7 Support for collaboration and exploitation

An important task for EXERTER is to be a link between manufacturers and other groups such as research institutes and academia, and to use this forum to discuss issues and ideas in relation to collaboration, requirements, regulations etc.

Due to the lockdowns in most EU countries caused by the COVID-19 Pandemic it has been challenging to bring the groups together during this period. Nevertheless, it has been possible to gather information on current research, development, and manufacturing in all the four stages (Prevention, Detection, Mitigation, and Reaction) of the EXERTER approach to SoE.

6 EXERTER Conference and webinar, outcomes

The annual EXERTER Conference was held on 6th of April 2022, 09:00 – 15:30 CET, as a virtual conference with about 158 registrations and at least 115 participants from several different countries, chaired by the BKA.

The topic of EXERTER Year 4, and thus of the conference, was "Criminal use of Explosives". This was illustrated with case studies, results of research and development from the past years, as well as legal assessments. The EXERTER consortium contacted experts from different research and police institutions, from universities and manufacturers, which had connections to this kind of scenario.

Table 3: Agenda

09:00	Registration	—
09:15	Welcome and introduction to EXERTER	FOI
09:20	Welcome and introduction to Year 4 Scenario "Criminal Use of Explosives"	BKA
09:25	Presentation of the results of the EXERTER Year4 National Workshops	INTERPOL
10:05	Misuse of pyrotechnics – a hazard assessment	BAM
10:45	Recent developments and research on training aids for explosive detection dogs	FOI, FhG-ICT, TNO
11:25	Attacks on ATMs	FOR-ZED
12:05	The use of IBNS to preventive ATM bombing and other related Physical attacks – Case Studies from Feerica	Feerica
12:45	BREAK	—
13:00	Criminal use of explosives in Sweden	Kemi, NFC Linköping
13:40	Chemical and isotopic profiling of the home-made explosive ETN	Uni of Amsterdam, NFI
14:20	Presentation of Year 5 Scenario / EXERTER Disseminations	PSNI
15:00	Discussion / Summary of EXERTER Virtual Conference	BKA, FOI
15:30	END OF CONFERENCE	—

In preparation of the conference, the presentations listed below were chosen to be meaningful for this scenario.

FOI/BKA - Welcome and introduction to EXERTER

FOI and BKA gave an introduction of the EXERTER project work, the four counter-attack domains PREVENT, DETECT, MITIGATE and REACT as well as the EXERTER network aims and selected outcomes from previous years.

BKA- Welcome and introduction to Year 4 Scenario "Criminal Use of Explosives"

The Introduction to the scenario was made by the EXERTER consortium member BKA, who also acted as the moderator of the conference. A quick overview regarding the aims of the Year 4 scenario "Criminal use of Explosives" was given by means of enumerating the main fields in which explosives, beside terrorist activities, were used in criminal or illegal ways in the recent years.

INTERPOL - Presentation of the results of the EXERTER Year4 National Workshops

The EXERTER consortium member INTERPOL introduced the outcomes of the EXERTER End-User Workshops 2021 on the scenario "Criminal use of Explosives". Due to the COVID pandemic, the workshops had been held on national levels.

The purpose of the workshops was to contribute to the information gathering by discussing requirements, needs and issues connected to the scenario. Also, the workshops gave the opportunity to share expertise by discussing ideas, working procedures and tools. The general aim was to give input to

important questions related to the EXERTER counter attack domains PREVENT, DETECT, MITIGATE and REACT, to be disseminated within EXERTER and within European explosives security community.

During the workshops, a questionnaire, aiming to gather information regarding the EXERTER Year 4 scenario implications within the daily work, was distributed. Afterwards, the discussions within the national communities were held, based on three main targets of "Criminal use of Explosives". These illegal goals were namely "financial gain" like attacks on ATMs, "power gain for criminal organisations" like gang crime and "personal gain" like misuse of pyrotechnics. These illegal goals were illustrated by small scenarios.

The conclusions, suggestions and requirements of the EXERTER National Workshops, were subsumed under the four EXERTER domains of PREVENT, DETECT, MITIGATE and REACT.

BAM - Misuse of pyrotechnics – a hazard assessment

A representative of the Federal Institute for Materials Research and Testing (BAM), gave a hazard assessment regarding the misuse of pyrotechnics. This contribution focuses on the categorisation of pyrotechnics, based on the EU-Directive 2013/29/EU and the conformity assessment for pyrotechnic articles. Also, the ways of misusing pyrotechnics were discussed and different types of pyrotechnics and their potential hazards were highlighted.

Another focus of the presentation was the so named "cold pyrotechnic". The evaluation of the explosive contents, combustion temperature and reaction products lead to the conclusion that this kind of pyrotechnic is still a very dangerous article if misused in confined areas.

This hazard assessment concerned the EXERTER counter attack domains PREVENT, MITIGATE, and REACT.

Fraunhofer Institute ICT/TNO/FOI - Recent developments and research on training aids for explosive detection dogs

The joint presentation of Fraunhofer Institute for Chemical Technology (ICT), the Netherlands Organisation for Applied Scientific Research (TNO) and the Swedish Defence Research Agency (FOI) presented the recent research and development on training aids for explosive detection dogs (EDD).

One part of the presentation was concerned with phlegmatization of TATP and HMTD with activated charcoal as training aid for explosive detection dogs (EDD). This part was covered by the lecture of the ICT. Before using the training aids, they were analysed, the insensitivity of the training aids was proven, the thermal stability and the vapour pressure have been examined as well. In addition, mass spectrometer measurements were undertaken. The high detection rate, in the practical detection tests with the EDD, had proven that activated charcoal as phlegmatizer for TATP and HMTD was suitable.

In the second part of the presentation, TNO informed about the effectiveness of 2D-printed explosives as "reward training aids" for passenger screening dogs. In order to be trained effectively, the dogs need to be confronted with a "reward" in an operational environment to maintain the required detection performance. Since bulk amounts of explosive threats are difficult to be taken and handled in an airport, alternative "reward aids" were required. Therefore, well-defined samples of different explosives, not interfering with the typical surface of the background, were 2D-printed on a surface. The quantity of explosive met all requirements for exclusion from Class 1 hazard classification and also did not meet the requirements of other hazard classes.

During the field tests, the printed samples were hidden inside containers, which were placed in a special target configuration, mixed with empty boxes. The result of these tests showed that properly trained dogs were able to respond adequately on the 2D-printed explosive reward training aids.

In the third part of the presentation, FOI covered issues connected to the requirements for the storage of explosives and what kind of change these explosives undergo. During the lecture, suitable storage conditions were discussed and the analysis of aging of the explosive material described. It was also

considered if materials which are stored for a long time still resemble authentic explosives and are functional / a threat, and if dogs can recognise new and aged materials sufficiently well.

Based on these considerations, a two-year study of nine different explosive materials has been conducted with the result that different components of the materials were affected differently by aging and have changed considerably in some instances during the test period.

The research and development of ICT, TNO and FOI fitted the EXERTER counter attack domains PREVENT, DETECT and REACT.

FOR Zürich - Attacks on ATMs

The Head of Zurich Explosives Disposal of the Forensic Institute (FOR-ZED) presented a case study regarding the raising number of attacks on ATMs in Switzerland from 2018 to 2022 and the various explosives used.

The explosion effects on ATMs and the nearby environment (buildings) were demonstrated. Focus was also put on relevant parts of the devices, and specific deformations of the surfaces of metals that were important within the investigations.

As a consequence of the rising problem of unexploded IEDs left within ATMs, the training of bomb technicians on how to face and handle such crime scenes was adapted and information for police units and first responders have been published. The assessment of attacks against ATMs indicated a continuous development of the modus operandi regarding explosives, activation systems etc.

The EXERTER counter attack domain of REACT was affected mostly by the results of the case study.

Feerica - The use of IBNS to preventive ATM bombing and other related Physical attacks – Case Studies from Feerica

A method describing how to counter ATM attacks effectively was presented by a representative of Feerica, an EU-based company from Portugal, specializing in ATM crime deterrence technologies. The raising professionalism of the perpetrators, and the establishment of complex criminal organisations, was put in relation to the raising investigation and personnel effort of the law enforcement agencies. The fast-developing evolution of the modus operandi regarding ATM attacks was also put in relation to the adaption of protective countermeasures that have to been taken by the money institutes (banks).

Feerica showed how the rapidly increasing number of, and the dangers emanating from, attacks on ATMs, was countered by their technology of Intelligent Banknote Neutralization System (IBNS). Smartstain IBNS was explained to be a certificated system that offers protection against all known types of ATM attacks in conjunction of monitoring tools for fast attack awareness and immediate response coordination with Law Enforcement Agencies.

In the presentation it was shown that in countries facing high ATM criminality rates, the cases had been reduced significantly by using the technique offered by Feerica.

The lecture of Feerica targeted the EXERTER counter attack domains of PREVENT, MITIGATE and REACT.

NFC/SEBDC - Criminal use of explosives in Sweden

How the Swedish National Forensic Centre (NFC) and the Swedish Bomb Data Centre (SEBDC) cooperate in casework, was demonstrated in their joint lecture regarding the criminal use of explosives in Sweden.

The NFC is responsible for forensic and laboratory work within the police authority, including strategical research and development. They support with their forensic expertise and education, whereas the SEBDC, as national and international point of contact, creates and maintains a national and international situation map and conducts threat assessment. It also analyses collected data, develops methods, provides intelligence and operational support, coordinates criminal investigations, offers force protection and supports the development in forensics.

It was shown that the number of explosions with criminal context in Sweden plateaued, after a maximum in 2019, on a high level. The devices were placed mainly at private residences and initiated at night-time, respectively in the early morning. The IED related events, typically explosions with criminal context, happened mainly in the bigger cities and in spatial proximity to highways.

The presentation concluded with a case study that illustrated the previous named statistical numbers.

The case studies presented fitted mostly the EXERTER domains of PREVENT and REACT.

University of Amsterdam/NFI - Chemical and isotopic profiling of the home-made explosive ETN

Over more than a decade, experts and scientists from TNO, the Netherlands Forensic Institute (NFI) and the University of Amsterdam had successfully collaborated to develop a forensic toolbox for chemical profiling and forensic attribution of energetic materials.

In his presentation, an expert of the University of Amsterdam illustrated this approach and its use in criminal investigations with a recent study into the chemical and isotopic profiling of the emerging home-made explosive Erythritol Tetra-Nitrate (ETN) for forensic attribution, reconstruction and intelligence. As a possibility to use this profiling it was made clear that the explosive casework in the Netherlands mostly relates to ATM raids, intimidation, illegal fireworks, targeted attacks, extortion and terrorism, committed by using different kinds of explosives. The subsequent forensic casework was mainly based on intact explosive devices, which was where the profiling could be best used.

Core topic of the presentation was the studies regarding chemical profiling of the home-made explosive ETN, with the aim to link crime scenes and suspects by linking the ETN material used in a not initiated Improvised Explosive Device (IED) to the raw material Erythritol used by the suspect who presumably built it. It was explained that the method can distinguish the Erythritol of different manufacturers based on the respective specifications, impurities and isotopic signatures.

The goal of connecting the IED to the suspect was successfully reached by using various analysis methods for the chemical attribution of the home-made explosive ETN: One Method aiming at the analysis of partially nitrated erythritol impurities and another method to analyse ETN and its precursors.

The studies on ETN covered the EXERTER domains of PREVENT, DETECT and REACT.

PSNI - Presentation of Year 5 Scenario / EXERTER Disseminations

The consortium member of the EXERTER project PSNI introduced the Year 5 scenario theme "Influences emanating from conflict zones and operational theatres" by outlining numerous potential scenarios.

The process for developing and researching the Year 5 scenarios and key points related to the four counter-attack domains PREVENT, DETECT, MITIGATE and REACT were presented.

Furthermore, the participants got information about upcoming events (Webinars) and publications (EXERTER Newsletter) in connection with the EXERTER project.

The conference concluded with the moderator of BKA, giving a short summary of the held presentations and the thanks to the lecturers and the audience.

During the conference, there was time for questions and discussions directly after and during each presentation. Through the chat-function (private and public), a possibility of networking was given and efficiently used.

In the aftermath of the conference, multiple requests for the presentation slides or to connect participants with the lecturers were facilitated by the organisation committee.

7 Analysis and recommendations

7.1 Overview

In the following sections, analysis and recommendation is provided concerning the attack scenario "Criminal use of explosives".

7.2 Prevent

To have explosives at their disposal, criminals often choose one of the following options:

- Steal explosives,
- Synthesise them, or
- Use pyrotechnics

Here, we present preventative methods that counter those strategies.

Past cases where explosives, precursors, and pyrotechnics have caused harm (by accident or on purpose) can illustrate the risk level to legislators, manufacturers and the public, who need to understand the danger better. With this improved understanding, laws and regulations governing explosives, precursors, and pyrotechnics have already become stricter, but should further be tightened.

For instance, since explosives (commercial and military) can be imported or smuggled from other countries, harmonised procedures for cargo checkpoints in the EU could reduce this risk. In addition, the smuggling of pyrotechnics is an issue since legislation differs between EU member states. One solution could include a unified European approach that specifies the type of legal products and limits their size.

Another idea is that more countries cover potential precursors to HMEs in addition to the already existing (and continuously updated) EU regulations. In addition, since anyone can find instructions on the internet for making explosive charges, surveillance of open sources (e.g., social media) could be considered (within the legal framework for storing and handling mass data).

Furthermore, businesses that legally use explosives (e.g., construction- and mining industry) should increase access requirements to avoid theft or illegal trade of explosives. In addition, regular background checks of all employees with access to explosives could be improved. An immediate reporting and rapid investigation of missing explosives could minimise the risk that they are being used for illicit purposes.

For increased legal certainty and more efficient processes, courts should provide prosecutors and lawyers specialising in explosives and simplify access to expert advice from explosives specialists. Moreover, convicting evidence may be found faster through improved cooperation between organisations and authorities. There is typically an excellent response rate and communication during and after crisis events, but sometimes a lack of communication in the prevention phase. Hence, communication could improve within institutions, between LEAs, between the military and civilian sectors, and on an international level.

Most of the identified projects fall into three focus areas: collaboration, video surveillance, and analysis.

Several projects revolve around improved collaboration between different LEAs and between the police and the public. CAPER, helps prevent organised crime through a platform for sharing, exploitation and analysis; INSPEC2T improves collaboration between police and the community; and UNITY involves the community in identifying policing priorities.

SAFEPOST raised postal security by screening parcels and TAKEDOWN analyses the dimensions of organised crime and terrorist networks

Video surveillance is the common focus of the following projects: SMARTPREVENT exploits the full potential of video surveillance; VALCRI analyses footage for sense-making in criminal intelligence analysis; and VICTORIA analyses videos for criminal and terrorist activities.

7.3 Detect

The identified requirements and gaps can be summarised as follows:

- Surveillance cameras (with suspicious behaviours analysis tool);
- Improved control of employed personnel;
- Detection equipment;
- To recognise the signs (e.g. signs that indicate an illegal business or HME laboratories, suspicious behaviour, left behind bags);

The overview of SoE research activities for the detection phase has identified the following actions:

- An innovative solution that analyses crowd behaviour;
- Tool to accelerate video analysis;
- Video surveillance technologies within the security sector to assist operators of critical infrastructure;
- Recommendations concerning the operators' needs for explosives detection at locations that have a secure perimeter;
- Guidelines for preventing ATM attacks and for physical ATM security;
- Training of the staff who perform real-time monitoring of building alarms and CCTV covering the area around an ATM;
- Raising quality in Explosive Detection Dog (EDD) services;
- Key principles and guidelines on the use of EDD;
- Automated dog trainer devices;
- Contactless close- and long-range sensors for trace explosive detection on surfaces and concealed threat detection.

Due to the vast number and the nature of the selected scenarios, there is not a study available for every scenario; thus, concerning the detection phase, the chosen research activities mainly refer to the following scenarios:

- Misuse of pyro (13 activities);
- Attack on ATM (5 activities);
- Money Extortion (3 activities).

No activities were assigned to the following scenarios: Eliminate enemy, retribution, intimidation, vigilantism.

EXERTER 4th yearly scenario presents a wide variability in the modus operandi on how an attack could be potentially performed, making identifying detect solutions challenging. The detection phase for some of the proposed scenarios might be the weakest link in the C-IED chain for some of the proposed scenarios, especially when the presence of layers of defence cannot control the attack. Moreover, detection technology might not be the optimal solution for some scenarios because it would require training, well-developed and exercised SOPs, and mechanical and logistic support.

For some of the selected scenarios, cost-effective and scenario-specific measures to be widely and easily implemented to have a real benefit could be, for instance:

- The increased awareness of indicators of IED emplacement and potential use;
- Routine law enforcement activities may detect and prevent imminent bomb threats and stop a bomber from emplacing a device;
- The public or security personnel may observe suspicious activity, such as someone leaving an unattended bag at a site, and notify authorities;
- Improved surveillance with CCTV and EDD.

Moreover, many factors hinder the adoption of innovation (e.g., fragmented market, low market visibility, cultural barriers on the demand side, and ethical and legal societal issues). Innovation uptake can be a slow process full of decisions, usually taken by the buyers.

Together with the technical development of new technology, its validation for the intended use and the cost-effectiveness assessment, some ideas which has been brought up for actions could be:

- EU standardisation activities to best support user need;
- Enable collection/common access to data sets at the EU level.

Not only government initiatives (i.e., public funding or new legislation) are required for successful innovations in the long run. A successful future in the market can also depend on a genuine involvement, commitment, and partnership of potential clients in the security industry from the beginning. This would benefit a proactive collaboration between innovators and end-users of the technology.

Collaboration is essential to accelerate innovation at different stages and between various actors (e.g., governments, regulators, policymakers, industry, innovators, researcher teams, and users).

Another critical aspect to consider during the development of new technology for the detection phase is the ability to quickly adapt to the continuous development of the modus operandi regarding the methodology to perform an attack.

7.4 Mitigate

Countering terroristic attacks in the mitigate phase at public spaces, critical infrastructures and buildings of interest is well-established and has been a major field of research in the past and up to now. For example, the RIBS-project supported the design of effective and viable integrated security measures protecting infrastructures without affecting their business dynamics. VITRUV (Vulnerability Identification Tools for Resilience Enhancements of Urban Environments) contributed to enabling the development of more robust and resilient spaces in the field of urban (re)planning/ (re)design/(re)engineering. SPIRIT (Safety and Protection of built Infrastructure to Resist Integral Threats) aimed at developing tools to reduce damage, destruction, and disruption to large new and existing buildings.

However, the well-established measures and technologies that could be applied with respect to Scenarios 1.2, 2.1, 2.2, 2.3 and 3.2 are not suited. Because these attacks can occur everywhere, a comprehensive implementation is economically not feasible. As such, these measures are also not mentioned in respective design- or building codes and finally further research with respect to these scenarios from a mitigate perspective is evaluated as less rewarding compared to the other counterattack phases.

Countering attacks by IED neutralization in the criminal use of explosives domain is from a technological point of view identically to terroristic motivated attacks. With respect to the neutralization of IEDs, SUBCOP (Suicide Bomber Counteraction and Prevention) developed technologies and procedures that can be applied by the Police Security Forces when responding to a suspected PBIED (Person Borne Improvised Explosive Device). In ENCOUNTER (Explosive Neutralisation and Mitigation Countermeasures for IEDs in Urban/Civil Environment), besides innovative techniques for mitigation of IED effects, the neutralization of IEDs in urban/civil environment was investigated. The outcome of such research projects, as IED neutralizing technologies, can help mitigate explosion effects in the criminal use of explosives domain.

Physical and organizational solutions protecting ATMs (Scenario 1.1) are well established (Best practices for ATM security). These measures are related specifically to the prevention and detection of attacks (prevention of money theft) rather than physically mitigating explosion effects. Because measures that mitigate explosion effects are not mandatory, these are not applied widely due to economic reasons. Rather than expensively hardening the ATM and optimizing their environment at locations that are highly vulnerable or have been often the target of attacks, the ATM owners typically just decide to remove ATMs at places exposed to high-risks. Consequently, a field for further research could be the identification of simple and cheap technological and organizational measures to mitigate explosion

effects. The basis could be quantitative risk analyses, where different kinds of measures, their costs, and effectivity are evaluated against each other.

With respect to Scenario 3.1 (Misuse of pyrotechnics), preventive measures (including the detection at the soccer arena entrance) are strongly recommended and seem to be most promising. To mitigate the physical effects of these pyrotechnics, using structural measures is probably not applicable or necessary because of the small effective radius of such devices (compared to IEDs with high explosives). Of course, these pyro's can cause significant injuries to people in the close surroundings and cause secondary dangers such as mass panics. Therefore, organizational measures (evacuation, first aid) could mitigate the effects of a misuse of pyrotechnics, but these already should be covered by the existing evacuation guidelines and concepts (see e.g. Evacuation Planning Guide for Stadiums). As such, the need for further research and standardization activities with respect to the EXERTER specific attack scenario (Scenario 3.1) is evaluated as less rewarding compared to the prevent and detect counter attack domains.

7.5 React

The EXERTER Year 4 scenario of "criminal use of explosives" for financial gain, especially attacks on ATMs for cash, might be countered by improved CCTV inside and outside banks or ATMs. In addition to better surveillance, safety measures in the ATM should improve (e.g., explosion- and flameproof enclosure). Adapted ATMs can invalidate banknotes automatically by staining them with paint and marking them with artificial DNA, thus disincentivising ATM attacks. A trivial way to react could be to close money institutes and ATMs at night. ATM maintenance teams could use body- and dashboard cameras and mobile alarms or emergency buttons for their protection.

There are only limited options to react to money extortion. The police should establish or intensify communication and cooperation with local businesses (i.e., the victims).

Monitoring and surveillance of trafficking ammunition, pyrotechnics, and precursors on the darknet could be improved. The police could intensify investigations into gang crime and increase their presence in certain areas. Regarding the criminal use of explosives for power gain, the protection of explosives storages could be improved, together with possibilities for tracking and tracing explosives.

Regarding classification and certification, the requirements for dealing with and possessing specific types of pyrotechnics could be higher. Currently, the classification of pyrotechnic products depends on which notified body performs it, and an idea could include a unified European approach that classifies threats (e.g., pressure, sound) from commercial pyrotechnics via reproducible measurements.

In the field of misusing explosives, pyrotechnics for personal gain or to create chaos for its own benefit, the entry controls and surveillance at stadiums could be intensified. Effective countermeasures could include specialised dogs, personalised tickets, and improved CCTV inside and outside a stadium. Also, the communication between police, fans, and football clubs could be improved.

8 Abbreviations and Definitions

AI	Artificial Intelligence
SBIED	Suicide Borne Improvised Explosives Device
CBRN	Chemical, Biological, Radiological and Nuclear
C&C	Command and Control centre
CCTV	Closed-Circuit TeleVision, video surveillance
CEN	European Committee for Standardization
CENELEC CLC	European Committee for Electrotechnical Standardization
CEP	Complex Event Processing
D	Deliverable
EC	European Commission
E&C	Evaluation and Certification
EEC	End user and Expert Community, external group of stakeholders in the field of SoE which have agreed to support and interact with the EXERTER consortium
FTF	Foreign Terrorist Fighter
HME	Homemade Explosive
IED	Improvised Explosive Device
ISO	International Organization for Standardization
LEA	Law Enforcement Agency
LLT	Less than Lethal Tools
MS	Member State
NLP	Natural language processing
OCTN	Organised Crime and Terrorist Network
QR	Quick Response
PB-IED	Person Borne Improvised Explosive Device
R&D	Research and Development
SCP	Standing Committee of Precursors
SMA	Semantic Media Analysis
SNA	Social network Analysis
SoE	Security of Explosives
TG	Thematic Group
UAV	Unmanned Aerial Vehicle
WP	Work Package

Appendices

This chapter comprises the three following appendices:

- Appendix 1: Research projects,
- Appendix 2: Technologies, and
- Appendix 3: Technology one-pagers.

Appendix 1 briefly describes related research projects, their funding and duration, and links to their respective webpage.

Appendix 2 Technologies

Appendix 3 provides comprehensive summarises of individual techniques in the form of one-pagers that indicate product type, overview of characteristics, application- and market aspects, and a cost-estimation.

Appendix 1: Research projects

Appendix 1 briefly describes related Research projects, their funding and duration, and links to their respective webpage.

Project / publication short name	Project full name, publication title etc.	Grant	Topic/summary	Project duration	Website
3D-Forensics	Mobile high-resolution 3D-Scanner and 3D data analysis for forensic evidence	EU-FP7	The 3D-Forensics system is a mobile high resolution 3D-Scanner and 3D data analysis software to record and analyse footwear and tyre impressions as well as profiles left at crime scenes in 3D and colour with optical scanning technology.	05/2013-08/2015	https://www.3d-forensics.de/, https://cordis.europa.eu/result/rcn/166151_en.html
A4A	Alert for All	EU-FP7	Alert4All focuses on improving the effectiveness of one element of the People-Centred Early Warning Systems paradigm, namely alert and communication towards the population in crises management. This improvement shall be measurable in terms of cost-benefit ratio, number of affected citizens timely reached by alerts, trust of citizens on alerts and intended vs. actual impact of alert strategies.	03/2011-12/2013	https://cordis.europa.eu/project/rcn/98427_de.html, https://cordis.europa.eu/result/rcn/90724_en.html
ACCIS	Automatic Cargo Container Inspection System	National (Germany) with Israel	The ACCIS joint project set out to build a demonstration system for automatic detection of explosives and radioactive material in medium-sized cargo shipments, e.g. aircraft containers. The team also conducted research on how such technologies could be used at airports or border checkpoints. Their work was instrumental in creating rapid, fully automated inspection systems that will enable reliable, accurate detection of explosive and radioactive substances in cargo.	06/2010-05/2013	https://www.sifo.de/files/Israel_A4_Bekanntm._ACCIS_D.pdf; https://www.sifo.de/de/accis-automatisches-cargo-container-inspektions-system-2092.html
ACRIMAS	Aftermath Crisis Management System-of-systems Demonstration	EU-FP7	It is the aim of the ACRIMAS project to prepare a large scale European demonstration and experimentation programme within the FP7 Security Theme, facilitating European wide collaboration, cooperation and communication in crisis management and improving cross-fertilisation between Member State organisations.	02/2011-05/2012	https://cordis.europa.eu/project/id/261669
ACXIS	Automated Comparison of X-ray Images for cargo Scanning	EU-FP7	The main objectives of the project ACXIS are to develop a manufacturer independent reference data base for X-ray images of illegal and legitimate cargo, procedures and algorithms to uniform X-ray images of different cargo scanners and measurement parameters, and an automated identification of potentially illegal cargo.	09/2013-05/2017	http://www.acxis.eu/
ADABTS	Automatic detection of abnormal behaviour and threats in crowded spaces	EU-FP7	ADABTS aims to facilitate the protection of EU citizens, property and infrastructure against threats of terrorism, crime, and riots, by the automatic detection of abnormal human behaviour. ADABTS aims to address one of the key problems, the definition of abnormal behaviour, by extracting characterizations in realistic security settings based on expert classifications and the analysis of CCTV operator behaviour.	08/2009-07/2013	https://cordis.europa.eu/project/rcn/91158_en.html, https://cordis.europa.eu/result/rcn/155989_en.html
ADDPRIV	Automatic Data relevancy Discrimination for a PRIVacy-sensitive video surveillance	EU-FP7	The ADDPRIV project seeks to improve public safety by ensuring the individuals' privacy right, enriching the current video surveillance systems through an automatic discrimination of relevant data recorded.	02/2011 - 03/2014	http://www.addpriv.eu/
ADVISE	Advanced Video Surveillance archives search Engine for security applications	EU-FP7	ADVISE aims to design and develop a unification framework for surveillance-footage archive systems, in an effort to deal with the increasingly critical need to provide automated and smart surveillance solutions.	03/2012-02/2015	https://cordis.europa.eu/project/rcn/102502_de.html, https://cordis.europa.eu/result/rcn/151681_en.html
AirBrush	A fast non-intrusive vapour detection system that rapidly identifies explosives in public areas	EU-H2020	The Eye on Air solution is a fast non-intrusive screening system for detecting explosive materials in public areas. The overall objective of AirBrush innovation project is to optimize the AirBrush design and validate its performance through pilot test with NCTV at Schiphol Airport (one of the largest airport in Europe) in order to obtain relevant certification and credibility.	04/2018-03/2020	https://cordis.europa.eu/project/rcn/217447/factsheet/en

AISIS	Automated generation of information and protection of critical infrastructures in the event of a disaster	National (Germany)	Structural monitoring and real-time assessment, material development (HPC)	05/2008-04/2011	https://www.sifo.de/de/aisis-automatisierte-informationsgewinnung-und-schutz-kritischer-infrastruktur-im-1823.html
ALADDIN	Advanced hoListic Adverse Drone Detection, Identification Neutralization	EU-H2020	ALADDIN will study, design, develop, and evaluate, in series of complementary pilots, a counter UAV system as a complete solution to the growing UAV threat problem, building upon a state-of-the-art system and enhancing it by researching on various detection and neutralization technologies and functionalities.	09/2017-08/2020	https://aladdin2020.eu/
ALARM	Adaptive solution platform for active technical support when saving human lives	National (Germany)	This project looked at ways of improving resource deployment in the event of a major incident, particularly in the initial phases. It set out to develop an adaptive IT system for supporting command centres, including RFID patient tagging and telemedical care to minimise fatalities. The scenario used was an explosion on a train at Berlin's Ostbahnhof station. The focus was on care for the injured, use of existing and new communication systems plus mobile devices and information provision to persons in the affected area via mobile phone.	02/2009-01/2012	https://www.sifo.de/files/SuRvM_600x800_ALARM.pdf
AMBOS	Defence against unmanned aerial vehicles for authorities and organisations with security roles	National (Germany) with Austria	The bilateral German-Austrian project AMBOS would create a system for anti-drone defence in defined security zones. The intention was that it will detect approaching drones, analyse their threat potential and develop effective defence measures. The aim was that the system will facilitate early identification of unmanned aerial vehicles and initiation of targeted intervention.	02/2017 – 06/2019	https://www.sifo.de/files/Projektumriss_AMBOS.pdf;
APFel	Analysis of passenger movements at airports using backward and forward video data streams	National (Germany)	APFel's aim is to support the technical staff in the video control room in an airport. A person behaving suspiciously can be marked on the screen by the operator, making it easier to keep an eye on them through several cameras on their way through the airport. The movement tracks recorded in this way are compared with typical walking routes, e.g. in an airport, in order to be able to predict the probable further route by forward analysis.	01/2010 - 03/2014	https://www.sifo.de/de/apfel-analyse-von-personenbewegungen-an-flughaefen-mittels-zeitlich-rueckwaerts-und-1855.html
ARENA	Architecture for the recognition of threats to mobile assets using networks of multiple affordable sensors	EU-FP7	ARENA addresses the design of a flexible surveillance system for detection and recognition of threats towards deployment on mobile critical assets/platforms such as trucks, trains, vessels, and oil rigs.	05/2011-05/2014	http://www.arena-fp7.eu/
ARGOS	Advanced protection of critical buildings by overall anticipating system	EU-FP7	Using data mining, data fusion and what are known as 'rule based engines' ARGOS, which stands for Advanced Protection of Critical Buildings by Overhauling Anticipating Systems, has developed an innovative early warning security system, letting site operators know if there is a potential threat.	01/2014-12/2015	https://cordis.europa.eu/project/rcn/111497_en.html, http://argosfp7project.blogspot.com/
ARGUS 3D	Air guidance and surveillance 3D	EU-FP7	The project aims to improve the detection of manned and unmanned platforms by exploiting the treatment of more accurate information of cooperative as well as non-cooperative flying objects, in order to identify potentially threats.	12/2009-02/2013	https://cordis.europa.eu/project/rcn/93528_en.html
AUGGMED	Automated Serious Game Scenario Generator for Mixed Reality Training	EU-H2020	The aim of AUGGMED is to develop a serious game platform to enable single- and team-based training of end-users with different level of expertise from different organisations responding to terrorist and organised crime threats.	06/2015-05/2018	http://www.auggmed-project.eu/, http://www.auggmed-project.eu/knowledge-hub.aspx
AURIS	Autonomous risk and information system for structural analysis and health monitoring of security-relevant buildings	National (Germany)	Security management system critical infrastructure, monitoring, progressive collapse analysis	06/2011 - 05/2015	https://www.sifo.de/de/auris-autonomes-risiko-und-informationssystem-zur-strukturanalyse-und-ueberwachung-1980.html

AVERT	The Autonomous Vehicle Emergency Recovery Tool	EU-FP7	The Autonomous Vehicle Emergency Recovery Tool (AVERT) shall provide a unique capability to Police and Armed Services to rapidly deploy, extract and remove both blocking and suspect vehicles from vulnerable positions such as enclosed infrastructure spaces, tunnels, low bridges as well as under-building and underground car parks.	01/2012-03/2015	http://avertproject.eu/, https://cordis.europa.eu/result/rcn/147699_en.html
BASYLIS	Mobile, autonomous and affordable system to increase security in large unpredictable environments	EU-FP7	The BASYLIS project was defined to contribute to increase the security of the European citizens by the developments of an adaptable and affordable system for temporal or permanent protection of facilities, perimeters and people using the combination of multiple technologies.	05/2011-5/2013	https://cordis.europa.eu/project/rcn/98755_en.html, https://cordis.europa.eu/result/rcn/91097_en.html https://www.beat-eu.org/
BEAT	Biometrics Evaluation and Testing	EU-FP7	The BEAT project devised a new framework of standard operational evaluations for biometric technologies. To achieve this, it first evaluated the performance and vulnerabilities of biometric systems, in addition to assessing privacy preservation mechanisms.	03/2012-02/2016	https://www.beat-eu.org/, https://cordis.europa.eu/result/rcn/198621_en.html
BESECU	Human behaviour in crisis situations: a cross-cultural investigation in order to tailor security-related communication	EU-FP7	BESECU (Behavior, Security and Culture) was an investigation of cross-cultural differences of human behavior in crisis situations in order to better tailor security-related communication, instructions and procedures.	05/2008-12/2011	https://cordis.europa.eu/project/rcn/86260_en.html, https://cordis.europa.eu/result/rcn/85720_en.html
BONAS	Bomb factory detection by Networks of Advanced Sensors	EU-FP7	To develop a system for detecting ongoing illicit production of explosives and improvised explosive devices (IEDs) in urban areas. The aim of BONAS is to design, develop and test a novel wireless sensors network for increasing citizen protection against terrorist attacks, in particular against the threat posed by IED devices.	04/2011 - 12/2014	https://cordis.europa.eu/project/id/261685
BRIDGE	Bridging resources and agencies in large-scale emergency management	EU-FP7	The ultimate goal of BRIDGE is to increase the safety of citizens by developing technical and organisational solutions that significantly improve crisis and emergency management in the EU Member States.	04/2011-06/2015	http://www.bridgeproject.eu/en, https://cordis.europa.eu/project/rcn/98624/brief/de
C2-SENSE	Interoperability Profiles for Command/Control Systems and Sensor Systems in Emergency Management	EU-FP7	C2-SENSE project's main objective is to develop a profile based Emergency Interoperability Framework by the use of existing standards and semantically enriched Web services to expose the functionalities of C2 Systems, Sensor Systems and other emergency/crisis management systems.	04/2014-09/2017	https://cordis.europa.eu/project/rcn/185495_de.html
CAPER	Collaborative information, Acquisition, Processing, Exploitation and Reporting for the prevention of organised crime	EU-FP7	The goal of the CAPER project is to create a common platform for the prevention of organised crime through sharing, exploitation and analysis of Open, and optionally, Closed information sources. CAPER will support collaborative multilingual analysis of audiovisual content (video, audio, speech and images) and biometrics information, supported by Visual Analytics and Data Mining technologies.	07/2011-10/2014	http://www.fp7-caper.eu/
CAPTEX	Detection of explosives vapor with a sensor array based on carbon nanowires	National (France)	Detection of explosives vapor with a sensor array based on carbon nanowires	03/2010-02/2013	
CascEFF	Modelling of dependencies and cascading effects for emergency management in crisis situations	EU-FP7	CascEff will improve our understanding of cascading effects in crisis situations through the identification of initiators, dependencies and key decision points. These will be developed in the methodological framework of an Incident Evolution Tool which will enable improved decision support, contributing to the reduction of collateral damages and other unfortunate consequences associated with large crises.	04/2014-7/2017	https://cordis.europa.eu/project/rcn/185490_de.html
CAST	Comparative assessment of Security-Centered Training Curricula for First Responders on Disaster Management in the EU	EU-FP7	Security-centered training course curricula on disaster management for first responders (FR)* in EU member states will be comparatively assessed with a specially developed matrixbased software: (1) for all EU member states (2) as derived from international best practices in the US, Russia and Israel as countries with extensive experience in this field.	07/2009-06/2011	http://cast.sbg.ac.at/

CATO	CBRN crisis management: Architecture, Technologies and Operational procedures	EU-FP7	CATO proposes to develop a comprehensive Open Toolbox for dealing with CBRN crises due to terrorist attacks using non-conventional weapons or on facilities with CBRN material. CATO brings an innovative and comprehensive answer to the diversity of organisational set-ups and of legacy systems for emergency preparedness and management (ICT, equipment, sensors, etc.).	01/2012-12/2014	https://cordis.europa.eu/project/rcn/102095_de.html, https://cordis.europa.eu/result/rcn/150411_en.html
C-BORD	effective Container Inspection at BORDer control prints	EU-H2020	The mission of C-BORD is to develop and test a comprehensive cost-effective TRL-7 solution for the generalised inspection of container and large-volume freight in order to protect EU borders, coping with a large range of container non-intrusive inspection (NII) targets, including explosives, chemical warfare agents, illicit drugs, tobacco, stowaways and Special Nuclear Material (SNM)	06/2015-11/2018	http://www.cbord-h2020.eu/
CBRNEmap	Road-mapping Study of CBRNE Demonstrator	EU-FP7	The CBRNEMAP project will lead to a plan for the development of technologies and systems needed for an optimised demonstration programme. The project is evaluating events leading up to, during and after a CBRNE terrorist incident as well as the potential roles of various sectors, including law enforcement, civil protection, rescue and health.	06/2010-09/2011	https://cordis.europa.eu/project/rcn/94694_de.html, https://cordis.europa.eu/result/rcn/90977_en.html
CEREX	Collaborative Effort for Raman Explosive detection	National (Sweden)	Raman spectroscopy has proven very useful for standoff detection of explosives over the last few years. CEREX is a project aimed at further developing Raman standoff detection for better sensitivity and trace detection of particle traces. Although a Swedish national project it also aims at collaboration with suitable partners in the US. Collaborative efforts are coordinated through DHS.	2009-2012/2013	
ChemAir	Near real-time detection of hazardous chemical substances in air cargo	National (Germany)	This project is aiming to develop a screening system specifically for air cargo, using a mass spectrometer to detect hazardous chemical substances.	03/2013 - 05/2016	https://www.sifo.de/sifo/de/projekte/schutz-kritischer-infrastrukturen/sicherheit-im-luftverkehr/chemair/chemair-echtzeitnahe-detektion-efahrstoffen-in-der-luftfracht.html
ChemSniff	Chemical sniffer device for multi-mode analysis of threat compounds	EU-H2020	ChemSniff will develop a multi-mode sniffer device for real-time detection of chemical compounds contained in CBRN-E substances. This will enable high throughput screening of soft targets such as vehicles, people and their personal effects.	09/2015-08/2018	https://cordis.europa.eu/project/id/674716
CHEQUERS	Compact High pErformance QUantum cascadE laseR Sensors	EU-H2020	CHEQUERS will develop two devices. The first will be a tripod-mounted device which will utilise a very high-finesse broadly tunable ring-resonator QCL coupled with a raster scanning imaging head with high backscattered radiation collection capability. The second device will address the urgent requirement for highly portable low-cost detection hardware. By working with potential end users of the devices, the ultimate goal of the CHEQUERS project is to develop a highly impactful technology, which will deliver safety, security and economic benefit to society.	03/2015-02/2019	https://cordis.europa.eu/project/id/645535
ChipSenSiTek	Fibre-optical micro-sensors for the real-time detection of explosives	National (Germany)	The aim of the project is to study a novel miniaturized sensor principle. The concept is a special coating of the sensors, so that the selective and highly sensitive detection of different classes of explosive becomes possible. These sensors are suitable for installation in a sluice gate with an integrated airstream, so that contaminations on clothes, for example, can be carried by the airstream.	10/2007-09/2010	https://www.sifo.de/sifo/de/projekte/schutz-kritischer-infrastrukturen/detektion-von-gefahrstoffen/chipsensitek/chipsensitek_node.html

CIPRNET	Critical Infrastructure Preparedness and Resilience Research Network	EU-FP7	The Critical Infrastructure Preparedness and Resilience Research Network or CIPRNet establishes a Network of Excellence in Critical Infrastructure Protection (CIP) R&D for a wide range of stakeholders including (multi)national emergency management, critical infrastructure (CI) operators, policy makers, and the society. CIPRNet builds a long-lasting, durable virtual centre of shared and integrated knowledge and expertise in CIP and CI MS&A (Modelling, Simulation and Analysis) by integrating part of the resources of the CIPRNet partners and their R&D activities acquired in more than 50 EU co-funded projects. This centre will form the foundation for the European Infrastructures Simulation & Analysis Centre (EISAC) by 2020.	03/2013-02/2017	https://ciprnet.eu/summary.html
CITY.RISKS	Avoiding and mitigating safety risks in urban environments	EU-H2020	The main objective of the City.Risks project is to increase the perception of security of citizens in cities by activating in a more transparent and sustainable way their participation in communities, through which information and interventions can be provided both to proactively protect citizens from falling victims to criminal activities as well as to reactively provide more timely and effective response and assistance.	05/2015-04/2018	https://cordis.europa.eu/project/id/653747
COMMONSENSE	Development of a Common Sensor Platform for the Detection of IED "Bomb Factories"	EU-FP7	Development of modules for gas-phase detection of explosives with ppb sensitivity, Development of modules for water-phase detection of explosives with sub-ppm sensitivity,	01/2011 - 12/2013	https://cordis.europa.eu/project/rcn/97603_en.html
CONFIDENT	Confirmation, Identification and Early Warning of IEDs	EDA	The objectives of this project are two-fold: (i) to focus on the confirmation and the identification of relevant components of IEDs including electronic parts, explosives and chemical, biological, radiological and nuclear (CBRN) payloads prior to the release of the agents and (ii) to provide complementary early warning capabilities.	2017-2020	https://eda.europa.eu/news-and-events/news/2018/11/19/half-way-from-the-concept-to-joint-technology-demonstration
CONSORTIS	Concealed Objects Stand-Off Real-Time Imaging for Security	EU-FP7	The project will develop a demonstrator for stand-off real-time concealed object detection for future implementations of high throughput security screening for European mass markets and infrastructure security. The technological approach will build on and extend current millimetre-wave imaging technology.	01/2014-12/2017	https://cordis.europa.eu/project/id/312745
COPE	Common Operational Picture Exploitation	EU-FP7	The Common Operational Picture Exploitation (COPE) project will integrate COTS solutions and novel technologies to achieve a step change in information flow both from and to the first responder in order to increase situational awareness across agencies and at all levels of the command chain.	02/2008-01/2011	https://cordis.europa.eu/project/id/217854
COPRA	Comprehensive European Approach to the Protection of Civil Aviation	EU-FP7	The objective of COPRA was to develop requirements and recommendations for future research activities which could lead to a more resilient, flexible and comprehensive approach.	09/2011-02/2013	https://cordis.europa.eu/project/rcn/100081_en.html
CREATIF	CBRNE related testing and certification facilities – A networking strategy to strengthen cooperation and knowledge exchange within Europe.	EU-FP7	In the project CREATIF a network of testing facilities for security related products and services focused to CBRNE detection will be established. CREATIF will ensure a careful examination of existing testing protocols and relevant standards to suggest harmonization of testing in the field of CBRNE detection both on a geographic scale within EU-27 and on a technical level.	02/2009-07/2011	https://cordis.europa.eu/project/rcn/89927_de.html
CRIMP	Chemical risk identification and mitigation project		Chemical security countermeasures. Being able to identify, reduce and mitigate the risk posed by chemicals and their explosive precursors, which can be used to Home Made Explosive (HME) or Chemical Weapons. By working with industry, Academia and First responders from the emergency services to manage and identify potential threats.		https://www.interpol.int/en/Crimes/Terrorism/Chemical-and-Explosives-terrorism/Project-Crimp
CRIM-TRACK	Sensor system for detection of criminal chemical substances	EU-FP7	The aim of the CRIM-TRACK project is to demonstrate a working sensing device that can be developed into a portable, miniaturized, automated, rapid, low cost, highly sensitive, and simple "sniffer" and detection unit, based on a disposable micro-colorimetric chip.	01/2014-04/2017	https://cordis.europa.eu/project/rcn/111496_de.html, http://www.crimtrack.eu/about-crim-track

CRISIS	Critical incident management training system using an interactive simulation environment	EU-FP7	CRISIS is a project to research and develop an advanced critical incident management, interactive simulation environment for training security and emergency personnel in airport operational security. The prototype to be delivered will be distributed, scalable, collaborative interactive simulation environment that will enable training of crisis managers and their staff at airports, at different levels of the organization.	05/2010-10/2013	https://cordis.europa.eu/project/rcn/94447_de.html, https://cordis.europa.eu/result/rcn/147265_en.html
CRISP	Evaluation and certification schemes for security products	EU-FP7	CRISP aims at facilitating a harmonised playing field for the European security industry by developing a robust methodology for security product certification. CRISP will enhance existing security evaluation and certification schemes by offering an innovative evaluation methodology that integrates the security, trust, efficiency and freedom infringement assessment dimensions.	04/2014-03/2017	http://crispproject.eu/, https://cordis.europa.eu/result/rcn/202209_en.html
DANTE	Detecting and ANalysing TErrorist-related online contents and financing activities	EU-H2020	DANTE will deliver effective, efficient and automated data mining, analytics solutions and an integrated system to detect, retrieve, and analyse huge amounts of heterogeneous and complex multimedia and multi-language (in five languages) terrorist-related contents from both the Surface and the Deep Web, including the Dark Nets.	01-2016-02-2019	https://cordis.europa.eu/project/rcn/202691/factsheet/en
DARIUS	Deployable SAR Integrated Chain with Unmanned Systems	EU-FP7	The aim of the research project DARIUS is to create an adequate technological framework that enables sharing and exploitation of innovative technological tools and resources produced by different manufacturers, and are potentially belonging in different departments and agencies, as well as businesses in the Search and Rescue (SAR) sector.	03/2012-02/2015	https://cordis.europa.eu/project/rcn/102362/factsheet/en
D-BOX	Demining tool-box for humanitarian clearing of large scale area from anti-personal landmines and cluster munitions	EU-FP7	D-BOX will tackle the burning issue of anti-personal landmines and cluster munitions remaining from armed conflicts. This will be achieved through the development of innovative solutions that will be interfaced and integrated in a comprehensive toolbox that is going to provide demining stakeholders the best tools, methods and procedures.	01/2013-04/2016	https://d-boxproject.eu/, https://cordis.europa.eu/result/rcn/159934_en.html
DECOTESSC1	Demonstration of CounterTErrorism System-of-Systems against CBRNE phase 1	EU-FP7	The basic idea of DECOTESSC1 is an analysis and subsequent prioritization of the gaps between the current situation and the ideal situation of CBRNE system-of-systems counterterrorism.	04/2010-10/2011	https://cordis.europa.eu/project/rcn/94291_en.html
DEMASST	Demo for mass transportation security: roadmapping study	EU-FP7	DEMASST was the first phase of the FP7 demonstration programme for security in mass transportation with the task to provide a roadmap for the development and integration of system-of-system solutions.	01/2009-05/2010	https://cordis.europa.eu/project/rcn/91165_en.html
DESTRIERO	A DEcision Support Tool for Reconstruction and recovery and for IntEroperability of international Relief units in situations, including CBRN contamination Risks	EU-FP7	DESTRIERO aims at developing a next generation post-crisis needs assessment tool for reconstruction and recovery planning, including structural damage assessment through advanced remote sensing enriched by in-field data collection by mobile devices (buildings, bridges, dams) and related data integration and analysis, based on international standards, novel (automated) data and information interoperability across organisations and systems, in combination with an advanced multi-criteria decision analysis tool and methodology for multi-stakeholder information analyses, priority setting, decision making and recovery planning.	09/2013-08/2016	http://www.destriero-fp7.eu/, https://cordis.europa.eu/result/rcn/202760_en.html
DETECTER	Detection technologies, ethics, human rights and terrorism	EU-FP7	The project addresses the increasingly international character of counter-terrorism, the increasing use of informal mechanisms for altering law-enforcement practice to meet the threat of terrorism, and the great variety of detection technologies and their uses.	12/2008-01/2012	https://cordis.europa.eu/project/id/217862
DETEX	Standoff Detection of Explosives	National (Sweden)	The R&T project will focus on applying novel improvements of Raman spectroscopy to detect concealed explosives at 30 to 60 meters range. This performance level will be achieved by combining leading technological know-how from several different research areas and industry. Application, spectroscopy and explosives expertise will be combined with state-of-the art tunable UV-lasers and signal processing methods into a field demonstration system.	2008-2011	https://www.nato.int/nato_static_fl2014/assets/pdf/2022/5/pdf/0450-22-DEXTER-brochure-V1n.pdf

DEXTER-EXTRAS	Detection of Explosives and firearms to counter TERrorism - EXplosiveTRacedetection for Standex	NATO	A new NATO project, EXTRAS, led by research institutions in Italy and Serbia, will make it possible to detect explosives and prevent terrorist attacks on public transport. The project, funded by NATO's Science for Peace and Security (SPS) Programme, will use laser spectroscopy to identify explosive materials on potential bombers. The project is part of a NATO initiative to develop a system capable of detecting explosives and concealed weapons in real time and securing mass transport infrastructure, such as airports and metro and railway stations.	06/2018-05/2021	https://www.nato.int/nato_static_fl2014/assets/pdf/2022/5/pdf/0450-22-DEXTER-brochure-V1n.pdf
DEXTER-INSTEAD	Detection of Explosives and firearms to counter TERrorism - INtegratedSystem for Threats EArlyDetection	NATO	DEXTER: It aims to develop a system to detect explosives and firearms in public spaces, remotely and in real time, without disrupting the flow of passengers.	06/2019-12/2021	https://www.nato.int/nato_static_fl2014/assets/pdf/2022/5/pdf/0450-22-DEXTER-brochure-V1n.pdf
DEXTER-MIC	Detection of Explosives and firearms to counter TERrorism - Microwave Imaging Curtain	NATO	The first project in this initiative brings together experts from France (ONERA, the Office National d'Etudes et de Recherches Aérospatiales), Ukraine (the Usikov Institute for Radiophysics and Electronics at the National Academy of Sciences), and South Korea (the Seoul National University) to design and develop a microwave imaging system (3D). It will be able to detect explosives and concealed weapons in real time and will help secure mass transport infrastructures, such as airports, metro and railway stations. It aims to develop a system to detect explosives and firearms in public spaces, remotely and in real time, without disrupting the flow of passengers.	01/2018-12/2021	
DIGEX	Simulation des Bedrohungs- und Schadenspotentials von Explosivkörpern auf städtischer Ebene	National (Austria)	Based on an automatically generated 3D city model we perform a semantic segmentation of the image data to detect object classes like roofs, windows, vegetation, etc. We fuse the geometric content and semantic content into a common representation to prepare the model for its use as geometry in numerical calculations and perform a detailed simulation of explosive expansion within the model. Finally, we embed the 3D map and the simulation results into 3D visualization systems and Geo Information Systems (GIS) for use by disaster management units. For the first time, a photorealistic and intuitive visualization of threat scenarios will be available for training, planning and risk assessment.	06/2017-05/2019	https://projekte.ffg.at/projekt/2743743
DirtyBomb	Increased preparedness to CBRN incidents via first responders' joint exercises	DG Home	The project is focused on verifying preparedness of services, including realization police unit officers (RPUOs) from EU countries participating in exercises, on terrorist attacks with the use of the so-called "dirty bomb", identifying critical points to be improved and development of, on this basis, training materials for LEAs from EU, focusing primarily on the key issues identified during the exercises. The concept of exercises assumes gathering information from partners regarding schemes of conduct in their countries to a "dirty bomb" threat and then conducting activities according to the scenario and arrangements with partners in order to check the current state of preparation and practical knowledge of participants.		https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/how-to-participate/org-details/945346966/project/815151/program/31077817/details
DITSEF	Digital and Innovative Technologies for Security and Efficiency of First responders operation	National (France)	Digital and Innovative Technologies for Security and Efficiency of First responders operation	01/2010-03/2013	https://cordis.europa.eu/project/id/225404
DOGGIES	Detection of Olfactory traces by orthoGonal Gas identification technologies	EU-FP7	The DOGGIES project aims at demonstrating (1) an operational movable stand alone sensor for an efficient detection of hidden persons, drugs & explosives, (2) the potential adaptation of this solution for the detection of a much wider range of illegal substances. The project addresses trace detection: it relies on the combination of two technologies based on completely different physical principles, therefore qualified as "orthogonal": MIR-spectroscopy and IMS.	06/2012 - 11/2015	https://cordis.europa.eu/project/rcn/103810_de.html, https://cordis.europa.eu/result/rcn/153805_en.html
DOOR-ANTIEX	Protective system against explosion, chemical and biological agents for buildings	National (Romania)	The aim of the project is to develop optimal solution to design doors resistant against explosion, chemical and biological agents while maintaining the specific norms and economical efficiency	2016-2018	

DURCHBLICK	Detection of different improvised explosive and incendiary devices by means of intelligent analytical sensors	National (Germany) with Austria	The aim of the Austrian-German project DURCHBLICK was to provide a robot-assisted, high-performance sensor system that can examine objects - particularly those that are not accessible from all sides. The project would also investigate ethical and legal issues surrounding the use of this technology with regard to emergency personnel and third parties.	05/2017 – 05/2019	https://www.emi.fraunhofer.de/en/business-units/security/research/Projekt-DURCHBLICK-robotergestuetzt-Untersuchung-USBV.html
EDEN	End-user driven demo for CBRNE	EU-FP7	The EDEN project will leverage the added-value of tools and systems from previous R&D efforts and improve CBRNE resilience through their adaptation and integration in complex multi-national/agency CBRNE operations.	09/2013-12/2016	https://eden-security-fp7.eu/
EFFISEC	Efficient Integrated Security Checkpoints	EU-FP7	The EFFISEC Project aims to deliver to border authorities more efficient technological equipment that provides higher security level of identity and luggage control of pedestrians and passengers inside vehicles, at land and maritime checkpoints.	05/2009-01/2014	https://cordis.europa.eu/project/id/217991
ELASSTIC	Enhanced Large scale Architecture with Safety and Security Technologies and special Information Capabilities	EU-FP7	Safety, security and resilience of building complexes towards natural and man-made disasters	05/2013-04/2016	http://www.elasstic.eu/; https://cordis.europa.eu/result/rcn/194221_en.html
EMILI	Emergency management in large infrastructures	EU-FP7	The project EMILI ("Emergency Management in Large Infrastructures") is a European project which aims at a new generation of control systems for large Critical Infrastructures (CIs) like power grids and telecommunication systems, airports, railway / metro systems, and oil and gas pipelines.	01/2010-12/2012	https://cordis.europa.eu/project/id/242438
EMPHASIS	Explosive Material Production (Hidden) Agile Search and Intelligence System	EU-FP7	To develop a system for detecting ongoing illicit production of explosives and improvised explosive devices (IEDs) in urban areas.	10/2011 - 01/2015	http://emphasis-fp7.eu/the-emphasis-system.html
ENCIRCLE	European Cbrn Innovation for the maRket Cluster	EU-H2020	To improve its resilience to new CBRN attacks and threats, the EU needs a specialized, efficient and sustainable industry, competitive on a less fragmented EU market and globally. Capitalizing on its experience in the EDEN Demonstration Project, in other CBRN relevant projects, and in the CBRN market and supply chain, the ENCIRCLE consortium proposes an innovative approach to reach this goal in a short to long term perspective so that SMEs and large industries can propose and invest in the best innovations on the market	03/2017-03/2021	http://encircle-cbrn.eu/
ENCOUNTER	Explosive Neutralisation and Mitigation Countermeasures for IEDs in Urban/Civil Environment	EU-FP7	The objective of the ENCOUNTER project is to identify, explore and validate innovative techniques for mitigation and neutralisation of IEDs in urban/civil environment, which will be summarised in a recommendation matrix and will include software tool to assist clearing forces.	09/2012-11/2015	http://www.encounter-fp7.eu/, https://cordis.europa.eu/result/rcn/164511_en.html
ENTRAP	Enhanced Neutralisation of explosive Threats Reaching Across the Plot	EU-H2020	ENTRAP will create a step-change for the development and deployment of new IED prevention tools and techniques by allowing earlier and more accurate assessment of their effectiveness	05/2017 - 04/2020	https://www.entrap-h2020.eu/en
ERNCIP- DEMON	Explosives Detection Equipment (non-Aviation)	EU-JRC			
ERNCIP- DEWSL	Detection of Explosives and Weapons in Secure Locations	EU-JRC			https://erncip-project.jrc.ec.europa.eu/networks/tgs/dewsl
ERNCIP- VIDEO	Video Surveillance for Security of Critical Infrastructure	EU-JRC			
E-SPONDER	Holistic approach towards the first responder of the future	EU-FP7	E-SPONDER is a suite of real-time data-centric technologies which provides actionable information and communication support to first responders that act during abnormal events (crises) occurring in critical infrastructures. This information enables improved control and management, resulting in real time synchronization between forces on the ground (police, rescue, firefighters) and out-of-theatre command and control centres (CC).	07/2010-12/2014	https://cordis.europa.eu/project/rcn/94833_de.html

ESS	Emergency support system	EU-FP7	The Emergency Support System (ESS) is a suite of real-time data-centric technologies which will provide actionable information to crisis managers during abnormal events. This information will enable improved control and management, resulting in real time synchronization between forces on the ground (police, rescue, firefighters) and out-of-theater command and control centers (C&C).	06/2009-05/2013	https://cordis.europa.eu/project/rcn/91016_de.html
EULER	European software defined radio for wireless joint security operations	EU-FP7	The EULER project created a powerful communication system for use in the field by security organisations. The project gathered top end-user groups in Europe to define a robust, interoperable communication system.	03/2009-04/2012	https://cordis.europa.eu/project/rcn/106857_en.html, https://cordis.europa.eu/result/rcn/90567_en.html
EUROSKY	Single European Secure Air-cargo Space	EU-FP7	EUROSKY will deliver a high impact programme for advanced air-cargo security and facilitation measures to safeguard international supply chains and the security of citizens while fostering international co-operation and a broad stakeholder engagement from all segments of the air-cargo industry.	05/2013-04/2017	https://cordis.europa.eu/project/rcn/108456_de.html, https://cordis.europa.eu/result/rcn/202824_en.html
EVA	Risks associated with major public events – Planning, assessment, EVAcuation and rescue concepts	National (Germany)	The interdisciplinary team on this project set out to develop strategies for planning, assessing, evacuating and rescuing people at large events (e.g. football matches and the arrival of fans at stations) and to validate those strategies using simulation.	03/2009-02/2012	https://www.sifo.de/sifo/de/projekte/schutz-und-rettung-von-menschen/schutz-und-rettung-von-menschen/eva/eva_node.html
EXAKT	Near real time trace analysis of airborne chemical warfare agents and explosives	National (Germany)	A new flight time mass spectrometer is to be used for the near real time analysis of highly toxic or hazardous substances in the air. The mass spectrometer is linked to a new thermodesorption system which is based on the principle of continuous ingestion and concentration of air samples. The resulting mixture is then directly supplied to the mass spectrometer for analysis without time-consuming substance separation. (on-line, near real time (NRT) analysis of trace level (airborne) chemical warfare agents and explosives)	01/2008-12/2010	
EXPEDIA	Explosives Precursor Defeat by Inhibitor Additives	EU-FP7	Inhibition of explosive precursors. Increasing the knowledge about homemade explosives (HME). European guide for first responders with basic instructions on how to interpret findings on a crime scene when suspected bomb factories have been encountered is produced.	09/2014 - 01/2018	https://cordis.europa.eu/project/rcn/191144_en.html
FALKE	Fähigkeit des Abfangens von in gesperrte Lufträume eindringenden Kleinfluggeräten durch zivile Einsatzmittel. Translated: Ability to intercept small aircraft entering restricted airspace using civilian equipment	National (Germany)	The goal of the Counter-UAS system FALKE is to develop and demonstrate an overall technical and organizational concept for the defense against illegally operating UAS at Hamburg Airport. Taking into account all areas of responsibility and responsibility, this project should provide automated and standardized concepts from the detection of a UAS to the final automated use of an interception UAS, so that the solution can also be used as a blueprint for other airports.	11/2019 – 11/2022	https://bmdv.bund.de/SharedDocs/DE/Artikel/DG/UAV-Projekte/falke.html
FESTOS	Foresight of Evolving Security Threats Posed by Emerging Technologies	EU-FP7	FESTOS' main goal has been to identify and assess potentially evolving security threats originating from the abuse of emerging technologies and new S&T knowledge.	03/2009-12/2011	https://cordis.europa.eu/project/rcn/89978_de.html, https://cordis.europa.eu/result/rcn/85979_en.html
FEXIN	Forensic Explosives Intelligence	EU-Others	The FEXIN project (an acronym for Forensic EXplosives Intelligence) has three main themes: chemical profiling of illegal firework; impurity profiling to unravel synthesis conditions and raw material use; and explosive residue analysis in forensic traces.		https://www.forensicinstitute.nl/research-and-innovation/national-projects/fexin
FLORIDA	Flexible, semi-automated video forensics system for the analysis of mass video data	National (Germany) with Austria	This bilateral German-Austrian project created a system for visual and auditory analysis of mass image and video data. The aim was to make it possible to reconstruct the sequence of events more quickly and spot potential suspects promptly.	05/2017 – 05/2019	http://www.florida-project.de/index-en.html

FLUSs	Airport security system	National (Germany)	Airport security management	08/2008-12/2011	https://trimis.ec.europa.eu/project/airport-security-system
FOLLOW	Finance/Security practice after 9/11: Following the Money from Transaction to Trial	EU-H2020	The aim of FOLLOW is to understand and analyse the security practices that render financial transactions into security intelligence, into court evidence. The novel approach is to map the path of the suspicious financial transaction as a 'chain of translation.'	01/2016-08/2021	https://cordis.europa.eu/project/rcn/204457/factsheet/en
FORENSOR	Forensic evidence gathering autonomous sensor	EU-H2020	The FORENSOR project aims to develop a novel, ultra-low-power, intelligent, miniaturised, low-cost, wireless, autonomous sensor ("FORENSOR") for evidence gathering. The combination of built-in intelligence with ultra-low power consumption will make this device a true breakthrough for combating crime.	09/2015-02/2019	https://cordis.europa.eu/project/id/653355
FORESEC	Europe's evolving security: drivers, trends and scenarios	EU-FP7	The objective of the FORESEC support action is to tie together the multiple threads of existing work on the future of European security in an attempt to provide a more cogent guidance, orientation and structure to all future security related research activities.	02/2008-11/2009	https://cordis.europa.eu/project/rcn/88096_de.html, https://cordis.europa.eu/result/rcn/85923_en.html
FORLAB	Forensic Laboratory for in-situ evidence analysis in a post blast scenario	EU-FP7	FORLAB will deliver a novel systematic methodology for optimizing the evidence collection. The key innovation is the establishment and maintenance of a dynamic, real-time self-adaptable feedback loop between the data collection process at explosion scene and the data repository, with the aim of reducing the number of collected samples, improving the capability to recreate the scenario and fine-tuning the screening process.	03/2012-02/2015	https://cordis.europa.eu/project/rcn/102645_en.html
GES-3D	Multi-biometric face identification	National (Germany)	The goal of the GES-3D project was to develop a user-friendly, multi-biometric system for identifying people based on photographic or video data, using three-dimensional facial image data. From the very beginning, the research also looked at matters concerning people's right to determine what information is available on them; data security requirements were also examined and data protection aspects were taken into consideration when developing the methods.	01/2012 - 03/2015	https://www.sifo.de/sifo/en/research-projects/protection-against-crime-and-terrorism/biometrics/approved-projects-in-the-field-of-biometrics.html?nn=265714
GIFT-CBRN	Generic Integrated Forensic Toolbox for CBRN	EU-FP7	The aim of GIFT-CBRN is to develop a forensic toolbox for investigating CBRN incidents. This toolbox would provide (1) procedures, sampling methods and detection of CBRN agents at the crime scene, (2) traditional forensic laboratory methods for contaminated evidence and (3) laboratory methods for profiling the CBRN agents released at the incident.	09/2014-08/2017	https://giftforensics.eu/
HAMLeT	HAZARDOUS MATERIAL LOCALISATION & PERSON TRACKING	EU-FP7	HAMLeT demonstrates new capabilities for early detection, localization, and continuous tracking of individuals or groups carrying hazardous material within a multiple person flow. In particular, HAMLeT will show that only in an integrated multiple sensor system, the potential of chemical sensors for security applications can be fully exploited.	11/2006-02/2008	https://www.h-brs.de/de/anna/projekt-hamlet
HANDHELD	Handheld terahertz spectrometer for the detection of explosive hazardous liquids	National (Germany)	Portable device with which airport staff can detect hazardous substances – The primary intended use of the portable terahertz spectrometer is to detect explosive hazardous liquids.	01/2008-12/2010	https://www.sifo.de/files/CBRNE_600x800_HANDHELD.pdf
HANDHOLD	HANDHeld OLfactory Detector	EU-FP7	The core aim of the project was to create a cost-effective and portable means of detection that will assist border agents and civil law enforcement by complementing the role performed by detection dogs.	04/2012-03/2016	https://cordis.europa.eu/article/id/92157-mobile-detection-and-sensor-technology-for-safer-european-borders
HARMONISE	Holistic Approach to Resilience and Systematic Actions to make Large Scale UrbaN Built Infrastructure Secure	EU-FP7	The central aim of HARMONISE is to develop a comprehensive, multi-faceted, yet mutually-reinforcing concept for the enhanced security, resilience and sustainability of large scale urban built infrastructure and development.	06/2013 - 05/2016	https://cordis.europa.eu/project/id/312013

HECTOS	Harmonized Evaluation, Certification and Testing of Security Products	EU-FP7	To develop a framework for harmonised evaluation and certification schemes for security products. To create a roadmap for the development of new harmonized product certification schemes.	09/2014 - 01/2018	https://cordis.europa.eu/projec t/rcn/192051_en.html
HOMER	Homemade explosives (HMEs) and recipes characterisation – capability	EU-FP7	implement a study to mitigate the threat of HMEs from criminal and terrorist elements	11/2013 - 12/2016	https://cordis.europa.eu/projec t/rcn/110911_en.html
HYGAS	Hyperspectral gas sensor: hyperspectral sensor for rapid, automatic remote detection of hazardous substances	National (Germany)	The aim of this joint project was to create a hyperspectral sensor for remote detection of hazardous substances, which would enable hazardous substances to be identified and visualised automatically from a great distance. The intention behind the project was to facilitate reliable assessment of incidents and do away with time-consuming sampling procedures and analysis of the samples taken.	02/2008- 01/2011	
HYPERION	Hyperspectral imaging IED and explosives reconnaissance system	EU-FP7	The objective of the HYPERION project was to develop and test a system concept for on-site forensic analysis after an explosion. This included tools and procedures for safer use for the stand-off detection and identification of unexploded IEDs.	08/2012- 10/2015	https://cordis.europa.eu/projec t/rcn/104277_de.html, https://www.srie2016.com/ima ges/ich_optimize_backup_imag es/Hyperion.pdf
ICARUS	Integrated Components for Assisted Rescue and Unmanned Search operations	EU-FP7	The ICARUS project does not only focus on the development of tools and services, but also on the integration of these novel tools into the standard operating procedures of the end-users. ICARUS concentrates also on placing novel technological tools into the hands of the end users, thereby driving the acceptance and practical use of these tools.	02/2012- 01/2016	https://cordis.europa.eu/projec t/id/285417
IED-LOGISTICS	IED-Logistics	National (Sweden)	The handling of explosive material often leaves trace particles behind and the aim in this project is to further develop a sensor system for finding these trace particles. The system will be based on multispectral imaging Raman spectroscopy, utilising a UV laser; it will be mobile and suitable for field applications.	2011	https://www.foi.se/rest- api/report/FOI-R--3346--SE
IED-PROTECT	Composite modular structures for protection against complex effects of IED	National (Romania)	The project aims to obtain modular composite structures for ballistic protection, used to attenuate the destructive effects of improvised explosive devices. The proposed novel approach includes the design, manufacturing and testing of new cellular materials (ceramics and polymers), able to reduce the amplitude of the shockwave and to raise the protection level provided by the obtained modular composite structures for light armored vehicles and buildings.	10/2014 – 07/2016	
ILEANET	Innovation by Law Enforcement Agencies networking	EU Network	ILEAnet aims to build a sustainable organisational Law Enforcement Agency (LEA) practitioners network focused on research & innovation addressing LEA challenges, together with a community of individuals interested to exchange and collaborate in this area. By encouraging such discussion between practitioners and experts from academia and industry, the project will stimulate LEA capabilities to influence, develop and take up research, development and innovation (RDI) that is useful and usable for LEAs, and thus help them to tackle the major challenges they face	06/2017- 05/2022	https://cordis.europa.eu/projec t/id/740714
IMSK	Integrated Mobile Security Kit	EU-FP7	The IMSK project combined technologies for area surveillance; checkpoint control; CBRNE detection and support for VIP protection into a mobile system for rapid deployment at venues and sites (hotels, sport/festival arenas, etc) which temporarily need enhanced security. The IMSK accepts input from a wide range of sensor modules, either legacy systems or new devices brought in for a specific occasion.	03/2009- 02/2013	https://cordis.europa.eu/projec t/rcn/90096_en.html
INDECT	Intelligent information system supporting observation, searching and detection for security of citizens in urban environment	EU-FP7	The INDECT project worked on developing solutions designed for police and other law enforcement authorities in the EU. Focusing on automatic threat detection in urban environments, the project team developed a set of tools supporting decision-making in counteracting threats and criminal activities.	01/2009- 06/2014	https://cordis.europa.eu/projec t/id/218086

INDIGO	Crisis management solutions	EU-FP7	INDIGO aimed to provide a revolutionary solution to enable inter-organisational preparation and support response to transboundary crises and disasters, in any environment. INDIGO will allow for inter-organizational exercising, information sharing and analysis – mining both horizontal and vertical relations.	05/2010-04/2013	http://indigo.diginext.fr/EN/index.html
INSINKT	Novel Social Data Mining Platform to Detect and Defeat Violent Online Radicalization	EU-H2020	Insikt Intelligence is a Spanish SME led by the EYIF 2016 Female Web Entrepreneur finalist that developed INSIKT, a novel social data mining platform to detect & defeat violent online radicalization. An early version of INSIKT was validated by several EU law enforcement agencies (LEAs), approved and attracted commercial interest. This Phase 2 project will trial INSIKT at 4 European LEAs that are looking for effective tools to prevent radical messages from spreading and reaching people vulnerable to radicalization.	01/2017-3/2020	https://www.insiktintelligence.com/
INSPEC2T	Inspiring CitizeNS Participation for Enhanced Community PoliCing AcTions	EU-H2020	INSPEC2T projects' scope is to develop a sustainable framework for Community Policing that effectively addresses and promotes seamless collaboration between the police and the community.	05/2015-04/2018	https://cordis.europa.eu/project/id/653749
IRLDEX	STAND-OFF DETECTION OF EXPLOSIVES BY IR LASER BACKSCATTERING SPECTROSCOPY	National (Germany)	The collaborative project »IRLDEX« has developed a mobile system that can detect traces of explosives on surfaces using hyperspectral IR image analysis. The system relies on active, wavelength-selective laser illumination, synchronized with the collection of backscattered radiation by an infrared camera.	01/2008-12/2010	https://www.sifo.de/de/irldex-infrarot-laser-gestuetzte-abbildende-detektion-von-explosivstoffen-1845.html
ISITEP	Inter System Interoperability for Tetra-TetraPol Networks	EU-FP7	ISITEP will develop procedures, technology and legal agreements to achieve a cost effective solution for PPDR interoperability. ISITEP will demonstrate full radio interface migration for PPDR resources. ISITEP end users will drive requirements to guarantee legal, operational and technical coherence. In addition, a legal agreement template will be proposed for approval between Norway and Sweden within the project timeframe.	09/2013-12/2016	https://cordis.europa.eu/project/rcn/110050_de.html, https://cordis.europa.eu/result/rcn/227025_de.html
ISOTREX	INTEGRATED SYSTEM FOR ON-LINE TRACE EXPLOSIVES DETECTION IN SOLID AND VAPOUR STATE	EU-FP7	The ISOTREX project had the main aim to contribute to trace explosive detection with instrument development able to detect trace high energized materials. The modular design of the system will allow its separation into two sub-systems and their displacement in different checking points according to different scenarios.	01/2007-12/2008	https://www.slideserve.com/lassie/integrated-system-for-on-line-trace-explosives-detection-in-solid-liquid-and-vapor-state
ISSI	International Submillimeter-wave Stand-off Imager	National (Sweden)	ISSI was an international collaborative research and technology development programme to design and develop a prototype stand-off security imager for the detection of improvised explosives devices (IEDs) and weapons concealed on the body. While techniques to image people when close to a sensor have already been developed using the millimeter wavebands, ISSI will examine standoff ranges in the 5-50 m range as required by a number of applications scenarios including screening free flowing crowds in urban environments, remote checkpoints etc.	2009-2010	
K3	Information and communication strategies for crises and disasters	National (Germany)	The K3 project was working on an organisational and technical strategy for crisis communication. Its aim was to improve information sharing not only within and between the relief organisations but also with the public. The project would also be the first to analyse how rumours spread and what effect warnings on social media have.	02/2015 - 01/2018	https://www.sifo.de/files/Projektumriss_K3.pdf;

LAGEF	Laser technologies for assessing hazardous situations involving objects containing chemical and explosive hazardous substances	National (Germany)	The LAGEF project was taking an innovative approach to abandoned luggage (chemical composition of substances inside the object) – the idea is to realize a laser-drilling system to take samples from inside the suspicious item. The system will be operated from a remote-controlled robot platform of the kind used by police bomb disposal officers. The project will thus help ensure reliable detection of the substances in suspected explosives, enabling the risk to be assessed quickly and accurately.	11/2014-10/2017	https://www.sifo.de/sifo/en/research-projects/protection-of-critical-infrastructure/protection-against-explosion-hazards-and-chemical-accidents/approved-projects-in-the-field-hazards-and-chemical-accidents.html?nn=265712
LITMUS	Detecting early indicators of a chemical attack		Disrupting chemical attacks during the development stage. Providing first responders, whether they are law enforcement, fire and ambulance services, investigators as well as health and environmental authorities, with the skills to detect and help successfully prosecute those involved in planning or preparing a chemical attack, can help save lives		https://www.interpol.int/en/Crimes/Terrorism/Chemical-and-Explosives-terrorism/Project-Litmus
LoCo	Preventing low-cost terrorism	National (Germany)	The LoCo project aimed to align threat analyses with low-cost terrorism scenarios and to formulate recommendations both for situation-specific and technical prevention measures. The strategies developed on the project were incorporated into prevention recommendations, which were made available to governmental institutions, operators of infrastructure facilities, sociologists, criminologists and other terrorism researchers.	08/2010 - 11/2013	https://www.sifo.de/sifo/de/projekte/gesellschaft/gesellschaftliche-dimensionen/loco/loco_node.html
LOTUS	Localisation of Threat Substances in Urban Society	EU-FP7	create a demonstration system by which illicit production of explosives and drugs can be detected during the preparation and production phase of a terrorist plot	01/2009 - 12/2011	https://cordis.europa.eu/project/id/217925
Mil field trials	V1318	National (Netherlands)			
MiRTLE	Next generation, high performance, long range, standoff, concealed threat detection system to protect European citizens and critical infrastructure	EU-H2020	Radio Physics Solutions Ltd has developed MiRTLE (Millimetre-wave Radar Threat Level Evaluation), the world's first, high performance, long range (up to 50m), low cost, standoff "concealed threat" detection system for the protection of citizens and critical infrastructure. MiRTLE is capable of screening large groups of people automatically and autonomously, without operator intervention, in real-time. Our highly innovative system detects PBIEDs, guns (including 3D printed) and knives up to a range of 50m in real-time, with targets in motion, all without privacy concerns. The overall objective of this project is to successfully refine, scale-up and demonstrate our superior technology to our customer base. We are planning to capture an 8% market share of the improvised explosive devices (IED) and weapon detection market, which will in turn generate cumulative revenues of €161m, cumulative EBITDA of €43m by 2025 and create 302 high skilled jobs in Europe.	10/2018-07/2020	https://cordis.europa.eu/project/rcn/218222/factsheet/en
MisPel	Multi-biometric forensic person searches in large image and video databases	National (Germany)	The goal of the MisPel project was to develop a software solution that helps investigators identify quickly individuals of relevance to their cases. The legal research being conducted on the project was concentrating on analysing the legal requirements that have to be met in order for data to be captured, filtered and forwarded as well as assessing the extent to which evaluated image data can be used in court. The plan was to formulate a suitable, integrated data protection and security strategy. The social science research being done was therefore designed to deliver example criteria for privacy protection plus strategies for long-term deployment scenarios.	01/2012 - 04/2015	https://www.sifo.de/sifo/en/research-projects/protection-against-crime-and-terrorism/biometrics/biometrics_node.html

MOSAIC	Multi-modal situation assessment and analytics platform	EU-FP7	The distributed intelligence within the MOSAIC platform enables decision support for automated detection, recognition, geo-location and mapping, including intelligent decision support at various levels to enhance situation awareness, surveillance targeting and camera handover; these involve level one fusion, and situation understanding to enable decision support and impact analysis at level two and three of situation assessment.	04/2011-07/2014	https://cordis.europa.eu/project/rcn/98642_en.html
MUSICODE	UGV stand-off multi-sensor platform for IED component detection	EDA	This project will develop new unmanned ground vehicle (UGV) stand-off capabilities for detection of IED components by using remotely operated multisensory platforms.	2017-2020	https://eda.europa.eu/news-and-events/news/2017/01/12/eda-programme-launched-to-improve-ied-detection
NDE	Network for Detection of Explosives	EU Network	Detection of Explosives	06/2009-06/2011	
NOSY	New Operational Sensing sYstem	EU-H2020	The project NOSY is focused on the development of a new monitoring system equipped with miniaturised sensors which could, in case of suspicious substances, increase the efficiency of collection of evidence by police forces and law enforcement agencies.	09/2015-08/2018	https://cordis.europa.eu/project/rcn/196895_de.html, https://cordis.europa.eu/result/rcn/201127_en.html
OFDEX	Optical stand-off detection of explosives and improvised explosive devices	National (Germany)	OFDEX is working on optical stand-off detection methods for unnoticable detection of suicide bombers and car bombs from distances greater than 10 or 100 m (detecting TATP, TNT, DMNB and ANFO)	01/2006-12/2009	http://publica.fraunhofer.de/documents/N-106513.html
OPTI-ALERT	Enhancing the efficiency of alerting systems through personalized, culturally sensitive multi-channel communication	EU-FP7	The Opti-Alert project strives to improve the alerting of the general public in crisis situations through personalized culturally sensitive multi-channel communication.	01/2011-04/2014	https://cordis.europa.eu/project/rcn/97601_de.html, http://publica.fraunhofer.de/eprints/urn_nbn_de_0011-n-2907197.pdf
OPTIX	Optical Technologies for the Identification of Explosives	EU-FP7	OPTIX developed a transportable system for the standoff detection and identification of explosives in real scenarios at distances of around 20 m (sensor to target), using alternative or simultaneous analysis of three different complementary optical technologies (LIBS, RAMAN, IR)	11/2008-04/2013	https://cordis.europa.eu/project/rcn/88604_en.html
P5	Privacy preserving perimeter protection project	EU-FP7	EU-funded researchers have developed new privacy-respecting surveillance technology to detect sabotage and terrorism threats against critical infrastructure. Integrated elements of the system can communicate with each other and solve complex surveillances tasks collaboratively, ensuring that large areas can be monitored without infringing privacy.	08/2013-10/2016	https://cordis.europa.eu/project/rcn/109306_de.html, https://cordis.europa.eu/result/rcn/190903_en.html
PANDORA	Pandora	EU-FP7	PANDORA is a crisis management project developing a training toolset and environment, which aims to bridge the gap between tabletop exercises and real world simulation exercises.	01/2010-03/2012	https://cordis.europa.eu/project/rcn/93363_en.html
PI	Particle collection and dispersion measurements for more efficient detection of explosives	National (Sweden)	PI has some common efforts with the FP7 projects EFFISEC and LOTUS. A prototype of an electrostatic particle collector is modelled and built for testing and characterisation. However, the main focus for the remaining project duration were studying of particle traces left on vehicles and objects after handling and packaging lower vapour pressure explosives, both amount of residue and particle sizes are targeted in these studies.	2008-2010	
PICAEX	Blast protection of critical infrastructures	National (Spain)			
Plasma Focus	Plasma Focus	National (Italy)	The detection of illicit materials is presently performed with different methods and among them some of them include nuclear methods based on the detection of the effect of the impact of nuclear particles (mainly neutrons) over the target material. The project intends to exploit a neutron generation for the purpose above, based on a Plasma Focus machine repetitive, compact and small size to be operated with only deuterium.	07/2010-06/2012	

PLEXO	Ballistic protective panels for explosion mitigation in airports	FSI - EU grant ROFSIP2016OS 6A12P01	The project aims at developing materials and composite panels for blast and fragments mitigations in public crowded areas like airports	02/2016 – 02/2019	https://fed.mai.gov.ro/1962/panouri-de-protectie-balistica-pentru-limitarea-exploziilor-in-aeroporturi-plexo-proiect-rofsip/#
POLINEX	Portal with an inexpensive IMS network for contactless detection of explosives on the body	National (Germany)	The major goal of this project is the development of a portal for the standoff detection of traces of explosives to avoid attacks on critical infrastructures. The general aim of the sociological subproject consists in the identification of social, ethical and organizational demands for the implementation of this detection technology. The POLINEX research project is therefore developing a sensor-equipped portal that will enable even minimum traces of explosives in the air to be detected.	02/2017 - 01/2020	https://www.sifo.de/sifo/en/research-projects/protection-against-crime-and-terrorism/anti-terrorism-aspects-and-activities/anti-terrorism-aspects-and-activities_node.html
PRACTICE	Preparedness and Resilience against CBRN Terrorism using Integrated Concepts and Equipment	EU-FP7	The objective of PRACTICE project is to improve the preparedness and resilience of the EU member states and associated countries to an attack from a terrorist group using non conventional weapons such as CBRN (Chemical, Biological, Radiological and/or Nuclear agents) materials. The existing situation is characterized by a fragmented structure as regards technology, procedures, methods and organization on national level as well as EU-level.	05/2011- 10/2014	https://www.practice-fp7-security.eu/#&panel1-1, https://cordis.europa.eu/project/rcn/98969/factsheet/de
PREVAIL	Precursors of Explosives: Additives to inhibit their use including liquids	EU-FP7	To prevent the use of hydrogen peroxide (HP) and acetone as precursors to homemade explosives by the development of a series of novel inhibitors, and to ensure that the detection of ammonium nitrate (AN) based devices is facilitated by adding markers tailored to a very sensitive detection system.	09/2010 - 10/2013	https://cordis.europa.eu/project/rcn/95604_en.html
PREVENT	PRocurEments of innoVativE, advaNced systems to support security in public Transport	EU-H2020	The PREVENT project is proposing an advanced system that enables security forces to promptly detect suspicious individuals and dangerous items. The project will apply six common security scenarios that capture threats and vulnerabilities. The project will create an interactive online instrument aiming at the identification of a 'Common Challenge'. This 'Common Challenge' will serve as the basis for an advanced security system entirely compatible with the EU's privacy and data protection rules.	05/2019- 07/2020	https://cordis.europa.eu/project/rcn/222624/factsheet/en
PRIME	Preventing, Interdicting and Mitigating Extremist events: Defending against lone actor extremism	EU-FP7	The PRIME Project aimed to address these challenges (Lone Actor Extremist Events (LAEEs)) in order to 1) improve our understanding of LAEEs generally, 2) set out the scientific foundation for the development of analytical tools, and 3) inform the design of countermeasures for the prevention of lone-actor radicalisation, the disruption of lone-actor terrorist plots, and the mitigation of terrorist attacks carried out by lone extremists.	05/2014 - 04/2017	https://cordis.europa.eu/project/rcn/185518_en.html, https://cordis.europa.eu/result/rcn/213930_en.html
PRINCE	PRINCE- Preparedness Response for CBRNE INCidEnts		PRINCE aims to support first aid responders and law enforcement/security authorities by providing them with an evidence base for strategic level decisions related to prevention, detection, Respiratory Protection, Decontamination and response to CBRN event.	01/2019 – 12/2021	https://www.isfp-prince.eu/about/
PROACTIVE	PRedictive reasOning and multi-source fusion empowering AntiCipation of attacks and Terrorist actions In Urban EnVironmEnts	EU-FP7	The main goal of PROACTIVE is to research a holistic citizen-friendly multi sensor fusion and intelligent reasoning framework enabling the prediction, detection, understanding and efficient response to terrorist interests, goals and courses of actions in an urban environment. To this end, PROACTIVE will rely on the fusion of both static knowledge (i.e. intelligence information) and dynamic information (i.e. data observed from sensors deployed in the urban environment).	05/2012- 04/2015	https://cordis.europa.eu/project/rcn/103500/factsheet/de
PROTON	Modelling the PRocesses leading to Organised crime and TerrOrist Networks	EU-H2020	PROTON aims at improving existing knowledge on the processes of recruitment to organised crime and terrorist networks (OCTN) through an innovative integration between social and computational sciences. Moving beyond the state of the art, this integration will support evidence-based policies at the international, national and local level.	08/2016- 09/2019	https://www.projectproton.eu/

PyroProf	Chemical Profiling of Inorganic and Pyrotechnic Explosives	EU-H2020	The main research objective of the PyroProf project is to offer suitable analytical tools for the chemical profiling of inorganic explosives of forensic interest (e.g., ammonium nitrate based and pyrotechnic mixtures) for their use in forensic casework. This project will yield selective sampling strategies, novel separation methodologies by state-of-the-art CE-MS and IC-MS instruments, complementary statistical approaches and databases with further knowledge on explosive, precursor, and background compositions useful for forensic interpretation.	09/2017-09/2019	https://cordis.europa.eu/project/rcn/210582_en.html
RAPTOR	Rapidly deployable, gas generator assisted. Inflatable mobile security kits for ballistic protection of European civilians against crime and terrorist attacks	EU-FP7	The objective of the project is the development of a mobile, rapid deployable and inflatable structure for ballistic protection of European civilians against threat scenarios, such as crime and terrorist attacks.	01/2010-12/2013	https://cordis.europa.eu/project/rcn/93360_en.html
RECONASS	Reconstruction and Recovery Planning: Rapid and Continuously Updated Construction Damage, and Related Needs Assessment	EU-FP7	RECONASS will provide a monitoring system for constructed facilities that will provide a near real time, reliable, and continuously updated assessment of the structural condition of the monitored facilities after a disaster, with enough detail to be useful for early and full recovery planning.	12/2013-05/2017	http://www.reconass.eu/index.php/project
RED-Alert	Real-time Early Detection and Alert System for Online Terrorist Content based on Natural Language Processing, Social Network Analysis, Artificial Intelligence and Complex Event Processing	EU-H2020	The RED-Alert project will bring data mining and predictive analytics tools to the next level, developing novel natural language processing (NLP), semantic media analysis (SMA), social network analysis (SNA), Complex Event Processing (CEP) and artificial intelligence (AI) technologies. These technologies will be combined for the first time and validated by 6 law enforcement agencies (LEAs) to collect, process, visualize and store online data related to terrorist groups, allowing them to take coordinated action in real-time while preserving the privacy of citizens. The RED-Alert solution will outperform state-of-the-art solutions in terms of number of languages supported, privacy-preserving capabilities, usability, detection performance, real-time capabilities and integration capabilities	06/2017-09/2020	http://redalertproject.eu/
REHSTRAIN	German: "Resilienz des Deutsch-Französischen Eisenbahn-Hochgeschwindigkeitsverkehrs" Translation: Resilience of Franco-German high-speed rail transport	National (Germany)		10/2015-01/2018	
RESPONDRONE	NOVEL INTEGRATED SOLUTION OF OPERATING A FLEET OF DRONES WITH MULTIPLE SYNCHRONIZED MISSIONS FOR DISASTER RESPONSES	EU-H2020	RESPONDRONE will develop and validate an integrated solution for first responders to easily operate a fleet of drones with multiple synchronized missions to enhance their situation assessment capacity and own protection. This System of Systems will simplify and accelerate situation assessment and sharing, decision making and operations management, while requiring a small crew to operate it. Moreover, it will deliver high-level information to any involved control centre through an intelligent web-based system that can be operated and accessed from a remote site as well as serving as on-demand airborne communications network to allow people on the ground to communicate with the command centre in case of cellular coverage collapse.	05/2020-04/2022	https://cordis.europa.eu/project/id/833717
RIKOV	Risk management system for terrorist threats to passenger rail transport	National (Germany)	The objective of the project was to develop a solution that ensures a balance between security and liberty and is acceptable from a societal and ethical point of view. The approach was taken into consideration what can be achieved in terms of technical and organisational aspects and how far they can go, what makes economic sense and what is legally possible.	11/2012 - 10/2015	https://www.sifo.de/files/Projektumriss_RIKOV.pdf; https://www.sifo.de/de/rikov-risikomanagementsystem-bei-terroristischen-bedrohungen-des-schienengebundenen-1863.html

Risk-Track	Risk-Track	EU-Others	The RiskTrack project aims to respond to one of the most recent and challenging priorities of the European Union on successfully eradicating terrorist radicalisation and recruitment. Tracking tool based on social media for risk assessment on radicalisation.	2014-2020	
ROSFEN	Rapid On-site Forensic Analysis of Explosives and Narcotics	EU-FP7	The aim of the ROSFEN project was to deliver an advanced forensic platform for rapid, on-site direct detection and lab-quality analysis of explosives and their precursors. The ROSFEN platform developed during the project is designed to be a tool for sample collection, with on-site detection, screening and analysis of explosives with sensitivity and selectively comparable to state of the art laboratory instrument.	04/2013-07/2015	https://cordis.europa.eu/projec t/rcn/108075_en.html
SAFE INSIDE	Detection of security-relevant substances in places which are difficult to access	National (Germany)	The detection system will involve a combination of a mobile, highly selective and sensitive mass spectrometer as its central component and an infrared spectrometer. It will be able to search cavities which are difficult to access, containers and in particular different types of surfaces for traces of substances which are relevant to security interests. The equipment will be used in conjunction with various innovative sampling and enrichment techniques, including micro-invasive techniques.	01/2008-12/2010	
SAFECITI	Simulation platform for the analysis of crowds behaviour in urban environments with training and predictive capabilities	EU-FP7	The SAFECITI project proposes the creation of a simulation system for Police intelligence analysts to predict the behaviour of crowds in urban environments under specific threats or stresses (turmoil, violence, panic, catastrophes or terrorism) in order to train and develop better safety plans, and tactic operations.	03/2014-02/2016	http://safeciti.eu/safeciti/
SAFEPOST	Reuse and development of Security Knowledge assets for international postal supply chains	EU-FP7	SAFEPOST aims to raise the current level of postal security by integrating innovative screening solutions suitable for uninterrupted flow of the enormous volumes of parcels and letters with operational postal processes and the criminal and customs intelligence work in a European wide cooperative distributed model.	04/2012-07/2016	https://cordis.europa.eu/projec t/rcn/102916_de.html
SAFETY4RAILS	Data-based analysis for SAFETY and security protection FOR detection, prevention, mitigation and response in trans-modal metro and RAILway networkS	EU-H2020	By focussing on physical-only and cyber-only attacks, as well as combined cyber-physical attacks, the EU-funded SAFETY4RAILS project will develop methods to increase the safety and recovery of track-based intercity railway and intracity metro transportation.	10/2020-09/2022	https://cordis.europa.eu/projec t/id/883532
SAFEWATER	Innovative tools for the detection and mitigation of CBRN related contamination events of drinking water.	EU-FP7	SAFEWATER addresses the key drinking water incident management challenges at large, and in particular, the current shortcomings related to the contamination of water networks by CBRN agents - the lack of effective detection capacities, contamination warning systems, and decision support and management tools.	10/2013-12/2016	https://cordis.europa.eu/projec t/rcn/110459_de.html, https://cordis.europa.eu/result /rcn/197458_en.html
SAFFRON	Semantic Analysis against Foreign Fighters Recruitment Online Network	EU-Others	The aim of SAFFRON is to build a system able to support early detection of foreign fighters recruitment by terrorist groups in Europe, with a focus on ISIS and Al-Qaeda. It consists in studying recruitment communication strategies on social media (e.g. narrations, argumentative tropes and myths used), and their evolution in time, as well as identification of needs, values, cultural and social contexts of the target.	02/2016-01/2018	
SALIANT	Selective Antibodies Limited Immuno Assay Novel Technology	EU-FP7	SALIANT aims to develop a hand-held device for real-time analysis of trace levels of explosives, chemicals and drugs. The key innovation is a positive detection lateral-flow test for small molecules that is highly sensitive and simple to use making it ideally suited to deployment by First Responders at crime scenes and terrorist incidents.	09/2010-12/2013	https://cordis.europa.eu/projec t/rcn/95761_en.html
SAMURAI	Suspicious and abnormal behaviour monitoring using a network of cameras for situation awareness enhancement	EU-FP7	The aim of SAMURAI is to develop and integrate an innovative intelligent surveillance system for robust monitoring of both inside and surrounding areas of a critical public infrastructure site.	06/2008-11/2011	https://cordis.europa.eu/projec t/rcn/89343_de.html

SAVASA	Standards Based Approach to Video Archive Search and Analysis	EU-FP7	The SAVASA project proposes the creation of a video archive search platform that allows authorised users to perform semantic queries over different, remote and non-interoperable video archives this project will exploit the current trends in computer vision, video retrieval and semantic video analysis.	12/2011-05/2014	http://www.savasa.eu/, https://cordis.europa.eu/project/rcn/101579_de.html
SEARISE	Smart Eyes: Attending and Recognizing Instances of Salient Events	EU-FP7	Video record of a typical monitoring camera contains mostly common events with only a few frames showing events of particular interest. Same is true for snapshots taken in a crowded place: if anything unusual happens here it takes only a small fraction of the whole scenery and can easily go unnoticed amidst numerous other activities. SEARISE technology is capable to learn what is salient in a given scene by building observation models of activities. The learned models enable the automatic detection of highly salient events in real time.	03/2008 - 02/2011	https://cordis.europa.eu/docs/projects/cnect/6/215866/080/publishing/readmore/Searise-E.pdf; https://cordis.europa.eu/project/rcn/85425/factsheet/en
SECUREAU	Security and decontamination of drinking water distribution systems following a deliberate contamination.	EU-FP7	SecurEau developed an early warning system to minimise the public impact of such an attack. It has also created tools to rapidly locate the source of contamination and its spreading and ways to clean the water distribution system, including the inner walls of the pipes.	02/2009-01/2013	https://cordis.europa.eu/project/id/217976
SECUR-ED	Secured Urban Transportation - European Demonstration	EU-FP7	SECUR-ED rationale is to create a global European improvement in mass transportation security through the development of packaged modular solutions validated through the demonstrations, and made available to the full community of operators.	04/2011-09/2014	http://www.secur-ed.eu/, https://cordis.europa.eu/result/rcn/159612_en.html
SECUREMETRO	Inherently secure blast resistant and fire safe metro vehicles	EU-FP7	Increased safety and security of metro vehicles from terrorist attacks by explosives and firebombs through materials choices and design, thereby increasing resilience and reducing the impact of attacks on passengers, staff, infrastructure and property.	01/2010-06/2013	https://cordis.europa.eu/project/rcn/93370/factsheet/en
SECURENV	Assessment of environmental accidents from a security perspective	EU-FP7	The project will analyse major industrial and environmental accidents from a security perspective using foresight methods and scenario building techniques. Natural phenomena (fires, floods), industrial accidents (chemical, biological and other) and other possible threats on a broad perspective will be investigated.	05/2009-04/2011	https://cordis.europa.eu/project/rcn/90478_en.html, https://cordis.europa.eu/result/rcn/86090_en.html
SECURESTATION	Passenger station and terminal design for safety, security and resilience to terrorist attack	EU-FP7	The aim of the SECURESTATION project is to improve passenger station and terminal resilience to terrorist attacks and safety incidents through technologies and methodologies enabling design to reduce the impact of blast, fire and the dispersion of toxic agents on passengers, staff and infrastructure.	01/2011-03/2014	https://cordis.europa.eu/project/rcn/99071/factsheet/en
SED-V	Standoff Explosives Detection on Vehicles	DHS			
SenSE4Metro	Sensor based security and emergency management system for underground metro systems during disaster events	National (Germany) with India	The overall objective of the research within SenSE4Metro is to improve the security of persons in urban underground trains and underground stations in emergency situations and catastrophes, resulting from terrorist attacks on underground trains and train stations and natural disasters, such as earthquakes and flooding. Such situations always require the evacuation, rescue and recovery of persons from underground trains and stations. To significantly improve the security of persons in such situations, the tasks within the project include: vulnerability analyses, experimantal examinations, sudies of social behaviors, security management and emergency response systems.	01/2015 - 12/2018	http://www.sense4metro.org/index_en.html
SENSOREX	Development of a sensor for multiple and selective detection of consecrated explosives	National (Romania)	Development of a molecular imprinted polymer membrane usable in sensors for vapour detection of TNT	10/2014 – 07/2016	http://sensorex.incemc.ro/
SET-237	Printed Standards for Stand-off Detection	NATO	The goal of SET-237 is to develop common practices between nations, share information, and advance deposition methodologies to produce reliable test standards for a variety of optical technologies.	2016-2019	https://www.sto.nato.int/Lists/test1/activitydetails.aspx?ID=16059
SICMA	Simulation of crisis management activities	EU-FP7	The role of the SICMA project is to demonstrate 'if' and 'how' an integrated suite of modelling and analysis tools providing insights into the collective behaviour of the whole organisation in response to crisis scenarios could improve the effectiveness of the decision making process.	03/2008-08/2010	https://cordis.europa.eu/project/rcn/86253_en.html, https://cordis.europa.eu/result/rcn/91471_en.html

S-IED	Sensors for IEDs	EDA			
SIIP	Speaker Identification Integrated Project	EU-FP7	SIIP research project will develop a breakthrough Suspect Identification solution based on a novel Speaker Identification (SID) engine and Global Info Sharing Mechanism (GISM) which will identify unknown speakers that are captured in lawfully intercepted calls, in recorded crime or terror arenas and in any other type of speech medium and channel (including social-media).	05/2014-04/2018	https://cordis.europa.eu/project/id/607784
SinoVE Management	Security in open transport systems and railway management' (SinoVE)	National (Germany)	Collaborative research project 'Security in open transport systems and railway management' (SinoVE). Contribution of GFaI: Fundamental investigation of methods for the modeling of risk scenarios in complex transportation infrastructures. Development of an innovative safety management system for transport systems and railway management. Particular focus is placed on transport hubs for passengers transport. By simulating hazard situations, the new methods technically support security forces facing critical situations.	09/2008-08/2011	https://www.sifo.de/de/sinove-management-sicherheit-in-offenen-verkehrssystemen-eisenbahn-1829.html
SKRIBT	Protection of critical bridges and tunnels as part of roads	National (Germany)	Security of transport/traffic infrastructures: The goals of this interdisciplinary project were to identify potential risks for such structures (taking into account the current and future threat situation), to define the most effective protection measures and thus to make such structures considerably less vulnerable	03/2008-2011	http://www.skribt.org/aktuelles.htm; https://www.kritis.bund.de/DE/AufgabenundAusstattung/KritischeInfrastrukturen/Projekte/SKRIBT/skribt_node.html
SKRIBT+	Protection of critical bridges and tunnels	National (Germany)	Security of transport/traffic infrastructures: SKRIBTPLUS project was aimed to develop effective ways of assessing damage quickly and reliably following a fire or explosion. The project was building on the results of its predecessor, SKRIBT.	01/2012-12/2014	https://www.kritis.bund.de/DE/AufgabenundAusstattung/KritischeInfrastrukturen/Projekte/SKRIBT/skribt_node.html
SLAM	Standardisation of laboratory analytical methods	EU-FP7	SLAM is a project proposal for a supporting and coordinating activity with the objective of reviewing the needs for standardisation of CBRN analysis and suggesting a road map for its implementation.	04/2012-03/2014	https://cordis.europa.eu/project/rcn/103191_de.html, https://cordis.europa.eu/result/rcn/151171_en.html
SMARTPREVENT	Smart Video-Surveillance System to Detect and Prevent Local Crimes in Urban Areas	EU-FP7	The SmartPrevent project aims to enhance detection and prevention of crimes in local urban areas by exploiting the full potential of video-surveillance systems.	03/2014-04/2016	http://www.smartprevent.eu/
SMARTPRO	SMARTPRO /Lightweight, flexible and smart protective clothing for law enforcement personnel	EU-FP7	The concept of the proposed project lies in the development of lightweight and flexible protective clothing, incorporating smart functionalities and designated for law enforcement authorities.	04/2014-09/2017	https://cordis.europa.eu/project/id/607295
SNIFFER	A bio-mimicry enabled artificial sniffer	EU-FP7	The SNIFFER project proposes a highly innovative one-stop shop approach to complement dogs and leverage their capabilities. This approach is based on state-of-the-art technologies centred on a new generation of olfactory biosensors. The SNIFFER devices to be developed combine in a one-stop shop sampling, pre-concentration and pre-treatment with bio-mimicry, synthetic diamond sensor technology and multi-parametric training software.	02/2012-05/2015	https://cordis.europa.eu/project/rcn/102348_de.html, https://cordis.europa.eu/result/rcn/170344_en.html
SNIFFER	Sensory devices network for food supply chain security	EU-FP7	Project SNIFFER envisions the design and development of a network of distributed detection devices, capable of rapid, on-site detection of multiple kinds of agents and CBR agents with high sensitivity and specificity throughout the most vulnerable stages of the food supply chain (such as farms, large collection centers, wholesalers, etc…).	05/2013-04/2016	http://www.fp7-sniffer.eu/, https://cordis.europa.eu/result/rcn/198630_en.html

SNIFFLES	Artificial sniffer using linear ion trap technology	EU-FP7	The research will develop a universal gas sensor using modular technologies to function as an artificial sniffer. It will detect a range of substances, including but not limited to people, drugs, explosives (including weapons) and CBRNe. The technology will complement trained sniffer dogs. The technology proposed is based on linear ion trap (LIT) mass spectrometry (MS).	01/2012-07/2015	http://www.sniffles.eu/
SNOOPY	Sniffer for concealed people discovery	EU-FP7	The SNOOPY project addressed two major challenges in the field of security that have become increasingly important in the last years: i) detection of people hidden in cargos/containers crossing borders in illegal mode; ii) detection of threats arising from Li-ion batteries transported in airfreight. To this aim the SNOOPY project has developed an artificial, portable electronic nose, potentially suitable to work in a 24/7 mode, able to detect the presence of hidden people through the identification of molecules produced by human body, e.g. sweats compounds.	01/2014-12/2016	https://cordis.europa.eu/project/rcn/111313_de.html, https://cordis.europa.eu/result/rcn/204468_en.html
SPARTACUS	Satellite Based Asset Tracking for Supporting Emergency Management in Crisis Operations	EU-FP7	SPARTACUS will design, realise, test and validate in simulated and real world scenarios GALILEO-ready tracking/positioning solutions for critical asset tracking and crisis management.	11/2013-10/2016	http://www.spartacus-project.eu/
SPERO	Space technologies used in the management of disasters and major crises, manifested at local, national and regional levels	National (Romania)	To create a support platform for the management of emergency situations generated by natural disasters, industrial accidents, humanitarian crisis situations or extreme atmospheric and space phenomena. The project focuses on building a complex geo-spatial database, visualization, processing and analysis tools.	04/2017 – 03/2020	https://www.ici.ro/en/completed-projects/national-plan-for-research-development-innovation-pncdi-iii-2017-2021/spatial-technologies-in-disaster-and-crisis-management-at-the-local-national-and-regional-level-spero/
SPIDERS	Système Portable d'Inspection par RX pour la Détection et l'Identification des Explosifs et Risques chimiques pour la Sécurité	National (France)	Portable RX detector for identification of explosives and chemical agents	around 2007	https://anr.fr/en/funded-projects-and-impact/funded-projects/project/funded/project/b2d9d3668f92a3b9fbbf7866072501ef-5872b9f968/?tx_anrprojects_funded%5Bcontroller%5D=Funded&cHash=a21194775b55edb3efbcd69606ea090c
SPIRIT	Safety and Protection of built Infrastructure to Resist Integral Threats	EU-FP7	Enhancing security of large buildings against terrorist threats	08/2010-07/2013	https://cordis.europa.eu/result/rcn/158449_en.html
SSAFE-COMMS	Counter-Terrorism Crisis Communications Strategies for Recovery and Continuity	EU-FP7	The SAFE-COMMS project explored communication strategies for the aftermath of terror attacks. By analysing communication requirements and activities that follow attacks in different countries for effective crisis communications, the project delivered a comprehensive, flexible communication strategy for authorities.	04/2009-03/2011	https://faculty.biu.ac.il/~sshpiro/, https://cordis.europa.eu/result/rcn/86437_en.html

STAIR4Security	Standards, Innovation and Research for Security	H2020	The main objective of STAIR4SECURITY is to create a collaborative platform as single entry point for information on the security sector stemming primarily from research activities in order to allow better governance of standardization needs in the Disaster Resilience and Chemical Biological Radiological Nuclear and Explosive (CBRNe) sectors to be realised. The platform will be practitioner / policy making driven. It aims to permit a better overview of current and new projects being at, national, European and international level; ensuring more coordination between all stakeholders and responding more efficiently and timely to the critical needs following an agreed strategic vision and identified priorities. The STAIR4SECURITY project is coordinated by **CEN** bringing together a comprehensive, experienced and multi-disciplinary team with a highly diverse expertise and skills set.	2019 - 2020	http://cen-stair4security.eu/
STANDEX	Stand-off Detection of Explosives	NATO	In 2009, the NATO-Russia Council launched a project for the Stand-Off Detection of Explosives (STANDEX) on suicide bombers in mass transport. This project, which is supported by the NATO Science for Peace and Security Programme, developed technologies to detect explosives concealed on a person moving through a crowd, for example in a metro station at rush hour. At the same time, the detection efforts must cause minimal inconvenience to the large numbers of people who depend on mass transport in their daily lives.	2009-2013	https://www.nato.int/cps/en/natohq/news_104536.htm
STEP-2	Standards for test protocols for explosive threats	National (Sweden)			
STRUCTURES	Strategies for the Improvement of Critical Infrastructure Resilience to Electromagnetic Attacks	EU-FP7	STRUCTURES aims at analyzing possible effects of electromagnetic (e.m.) attacks, and in particular of intentional e.m. interference (IEMI), on such CI's, at assessing their impact for our defense and economic security, at identifying innovative awareness and protection strategies and at providing a picture for the policy makers on the possible consequences of an electromagnetic attack.	07/2012-10/2015	https://cordis.europa.eu/project/rcn/104107_de.html, https://cordis.europa.eu/result/rcn/154501_en.html
SUBCOP	Suicide Bomber Counteraction and Prevention	EU-FP7	SUBCOP sets out to develop technologies and procedures that can be applied by the Police Security Forces when responding to a suspected PBIED (Person Borne Improvised Explosive Device).	06/2013-07/2016	https://cordis.europa.eu/project/rcn/108806_de.html, https://cordis.europa.eu/result/rcn/170072_en.html
SUBITO	Surveillance of unattended baggage and the identification and tracking of the owner	EU-FP7	SUBITO researched and developed automated detection of abandoned luggage, fast identification of the individual responsible and the tracking of their subsequent path.	01/2009-10/2011	https://cordis.europa.eu/project/rcn/89391_de.html, https://cordis.europa.eu/result/rcn/87703_en.html
SUSQRA	Protection against unconventional explosive devices - Characterization and quantitative risk analysis	National (Germany)	Quantitative risk analysis; hazard sources; post-event forensic evaluation	09/2018-08/2021	https://www.emi.fraunhofer.de/en/business-units/security/research/susqra-sprengvorrichtungen-praevention-risikoanalyse.html
SYSTEM	SYnergy of integrated Sensors and Technologies for urban sEcured environMent	H2020	SYSTEM is the three-year innovation action awarded to a consortium led by Fondazione FORMIT addressing the challenge of the topic "Integration of detection capabilities and data fusion with utility providers' network" (SEC-10-FCT-2017) included in the 2016-2017 Work Programme "Secure societies – Protecting freedom and security of Europe and its citizens" of Horizon 2020.	09/2018-08/2021	https://www.systemproject.eu/
TACTIC	Tools, methods And training for CommuniTIes and society to better prepare for a Crisis	EU-FP7	TACTIC's main objective was to develop an online platform together with practitioners which can improve community preparedness to cross border and large scale hazards.	05/2014-04/2016	https://cordis.europa.eu/project/rcn/185509_en.html, https://cordis.europa.eu/result/rcn/191155_en.html

TACTICS	Tactical Approach to Countering Terrorists in Cities	EU-FP7	TACTICS seamlessly integrates new research results in the area of behaviour analysis, characteristics of the possible urban-based targets and situational awareness into a decision making framework comprising of a coherent set of tools and related processes, supporting security forces in responding more efficiently and effective to a given threat in order to actually prevent the attack or to limit its consequences.	09/2012-08/2015	http://www.fp7-tactics.eu/, https://cordis.europa.eu/result/rcn/156597_en.html
TAKEDOWN	Understand the Dimensions of Organised Crime and Terrorist Networks for Developing Effective and Efficient Security Solutions for First-line-practitioners and Professionals	EU-H2020	Organized Crime and Terrorist Networks (OC/TN) are a major challenge for the European Union and many different stakeholder groups are involved in creating awareness, preventing, identifying and intervene in case of risk or threat. But in order to develop better strategies and instruments, we still need a deeper understanding of these phenomena. TAKEDOWN therefore aims at generating such novel insights on OC/TN. In order to meet this challenge and to investigate this complex field of research a multidimensional modelling approach is used. The resulting, proprietary TAKEDOWN Model describes social, psychological, economic aspects as well as further dimensions, activities and response approaches. A comprehensive empirical research combined with European and international expert knowledge ensures a valid and intuitive model.	09/2016-08/2019	https://www.takedownproject.eu/
TASS	Total Airport Security System	EU-FP7	TASS is a multi-segment, multi-level intelligence and surveillance system, aimed at creating an entire airport security monitoring solution providing real-time accurate situational awareness to airport authorities.	04/2010-03/2014	https://cordis.europa.eu/project/rcn/94264_de.html, https://cordis.europa.eu/result/rcn/92983_en.html
TEKZAS	THz real-time camera (two-dimensional) for application in security technology	National (Germany)	The overarching objective of the project is to study and implement a multi-sensor system for the remote detection of hidden chemical, biological and explosive (CBE) hazardous substances carried directly on the body. Persons carrying such substances are moving in real time. The system to be developed will be based on terahertz (THz) technologies and include a surveillance camera and a two-dimensional camera in the THz spectral range.	10/2007-09/2010	
TENSOR	Retrieval and Analysis of Heterogeneous Online Content for Terrorist Activity Recognition	EU-H2020	The main focus of Project TENSOR is to keep people safe. The project which is funded by the EU under the Horizon 2020 programme will seek to develop a platform offering Law Enforcement Agencies fast and reliable planning and prevention functionalities for the early detection of terrorist activities, radicalisation and recruitment. (online content)	09/2016-08/2019	https://cordis.europa.eu/project/id/700024
TERAcam	Active, fully electronic, roomtemperature, real-time THz camera for security applications	National (Germany)	The aim is to develop and test a camera using THz technologies which enables real-time images, for example of objects hidden under clothing. Two laboratory camera systems will be developed in the course of the project: One system is to be suitable for long-distance early recognition enabling images at a distance of up to 20 metres. The second system will involve lower production costs but will only be usable for close-up images.	06/2007-05/2010	
TERASCREEN	Multi-frequency multi-mode Terahertz screening for border checks	EU-FP7	The objective of TeraSCREEN was to develop and demonstrate in a live border control environment a safe, privacy respecting, high throughput security screening system which automatically detects and classifies potential threat objects concealed on a person.	05/2013-10/2017	https://cordis.europa.eu/project/rcn/108442_en.html, https://cordis.europa.eu/result/rcn/158531_en.html
TeraTom	High-resolution THz tomography for security applications	National (Germany)	Additional equipment based on microwave imaging technology is to be used to support the screening of people in areas of enhanced security, at airports for example. The aim is to develop a prototype for close-range screening which enables high-resolution searches of small items, for example a shoe. The focus is on screening people for explosives, weapons and other dangerous items.	10/2007-09/2010	

THz-Videocam	Passive THz video camera for security applications to detect hidden objects at great distances	National (Germany)	The project develops a passive video camera which takes real-time pictures of moving objects at great distances in the THz spectrum. The camera shows hidden metallic and ceramic objects as well as chemical substances which cannot be visualized with existing optical techniques operating in the visible or infrared spectrum. A main characteristic of the presented solution is that is does not require the objects or persons to be directly exposed to radiation but records the objects' natural THz radiation.	08/2007-07/2010	
THz-Videocam-TWO	Demonstration of a wide-angle terahertz thermal image camera for access controls	National (Germany)	The THz-Videocam-TWO project aimed to develop a body scanner that does not require an active source of THz radiation and can be used for demonstration purposes. This type of system utilises humans' natural body heat, combined with highly sensitive sensors to measure that heat as thermal radiation. Any concealed dangerous items, such as knives or weapons, can thus be easily identified due to their lower heat emissions.	01/2012-12/2014	https://www.sifo.de/sifo/de/projekte/schutz-kritischer-infrastrukturen/detektion-von-gefahrstoffen/thz-videocam-two/thz-videocam-two-demonstration-era-fuer-die-personenkontrolle.html
TIRAMISU	Toolbox Implementation for Removal of Anti-Personnel Mines, Submunitions and UXO	EU-FP7	The TIRAMISU project aims at providing the foundation for a global toolbox that will cover the main mine action activities, from the survey of large areas to the actual disposal of explosive hazards, including mine risk education.	01/2012-12/2015	http://www.fp7-tiramisu.eu/
TRILLION	Trusted, Citizen – LEA Collaboration over social networks	EU-H2020	TRILLION delivers a fully-fledged platform to support the extensive collaboration between citizens and LEAs. The operational environment of the platform is not limited to an on-going crisis, but also extends to the period before it through early identification and prevention of emerging risks.	09/2015-08/2018	https://cordis.europa.eu/project/id/653256
UCTIL	Urban Chemical Threat Location and Identification	EU-H2020	Karsa intends to launch a product into the nascent UCTIL market by deploying a sensor network that can continuously monitor ambient air for multiple target compounds with high sensitivity and specificity. The base technology already exists and has been proven robust for ambient and mobile measurements. Continuously monitoring ambient air in a complex urban environment for low concentrations of many chemicals stretches the limits of state-of-the-art technology.	02/2019-07/2019	http://karsa.fi/
UNCOSS	Underwater coastal sea surveyor	EU-FP7	The main objective of UNCOSS project is to provide tools for the non-destructive inspection of underwater objects mainly based on neutron sensor. Detection of dangerous materiels (especially IED) and surveillance in wide maritime areas.	12/2008-07/2012	https://cordis.europa.eu/project/rcn/89678_de.html
UNITY	Unity	EU-H2020	Unity will create a new, community-centred approach to Community Policing: developing new tools, procedures and technologies, putting people at the heart of identifying policing priorities and ensuring citizens are an integral part of informing sustainable solutions.	05/2015-04/2018	https://cordis.europa.eu/project/id/653729
UNSETH	Unique Smart anti-tampering and Enveloping TecHnologies	EU-FP7	Embedded protection of security systems and antitampering technologies	01/2014-06/2017	https://cordis.europa.eu/project/rcn/111493_en.html
USBV-Inspektor	Multimodal sensor suite to support disarmament of improvised explosive and incendiary devices and the collection of evidence	National (Germany)	The partners on the "USBV-Inspektor" joint project were exploring the possibilities offered by a sensor suite comprising a millimetre wave scanner with which to screen the luggage, a 3D range scanner and a high-resolution camera. Mounted on a robotic platform, it will enable explosives and incendiary devices inside luggage to be detected quickly from a safe distance and extensive evidence to be secured for assessment in legal proceedings.	11/2014-12/2017	https://www.sifo.de/sifo/en/research-projects/protection-of-critical-infrastructure/protection-against-explosion-hazards-and-chemical-accidents/approved-projects-in-the-field-hazards-and-chemical-accidents.html?nn=265712

Våbeext	Quantitative mapping and analysis of the violent online political extremism spread through the Internet and social media in Sweden	National (Sweden)			
VALCRI	Visual Analytics for sense-making in CRIminal intelligence analysis	EU-FP7	The purpose of Project VALCRI is to create a Visual Analytics-based sense-making capability for criminal intelligence analysis by developing and integrating a number of technologies into a coherent working environment for the analyst we call the Reasoning Workspace.	05/2014-06/2018	https://cordis.europa.eu/project/rcn/188614_de.html, https://cordis.europa.eu/result/rcn/218541_en.html
VAPEX	Novel Vapour Analyser for the Detection of Explosives in Airports Passengers Checkpoints	Eurostars	The objective of VAPEX is to develop a People Screening Portal (TRL6) to scan both passengers and non-passengers in airport facilities for hidden explosives. Based on vapour phase detection, it is expected to provide advantages in terms of reliability, efficiency and non-intrusiveness compared to other methods.	9/2018 - 01/2020	
VASA	Visual Analytics for Security Applications	National (Germany)	The goal of VASA (Visual Analytics for Security Applications) is to apply visual analytics to disaster prevention and crisis response, with a focus on critical infrastructures in logistics, transportation, food safety, digital networks and power grids at the national levels. The German-US VASA joint project was therefore seeking to improve disaster preparedness and crisis management by employing visual analytics. The aim was to produce a demonstrator that will enable persons such as control centre or operation managers to grasp complex crisis situations quickly with the aid of visual evaluations.	01/2011 - 10/2014	https://www.va-sa.net/
VBIED	Vehicle Borne IED Detection	Other			
VBIED Characterization		National (Germany)	Characterization of debris hazard from VBIEDs		-
VICTORIA	Video analysis for Investigation of Criminal and TerrORIst Activities	EU-H2020	Video recordings have become a major resource for legal investigations. Since no mature video investigation tools are available and trusted by LEAs, investigators still need to carry out the analysis of videos almost exclusively manually. Current practices are too resource intensive to handle the yet huge and steadily increasing volume of videos that need to be analysed after crimes and terrorist acts. The consequence is that LEAs cannot analyse all available videos because of the huge effort needed, and the extraction of first clues from videos after a terrorist attack takes more time.
VICTORIA will address this need and deliver a Video Analysis Platform (VAP) that will accelerate video analysis tasks by a factor of 15 to 100 (depending on the use case), while providing very reliable results.	01/2017-03/2020	https://cordis.europa.eu/project/rcn/210226/factsheet/en
VIRTUOSO	Versatile information toolkit for end-users oriented open sources exploitation	EU-FP7	VIRTUOSO provides a technical framework for the integration of tools for collection, processing, analysis and communication of open source information. "Plug and play" functionalities that improve the ability of border control, security and law enforcement professionals to use data from across the source / format spectrum in support of the decision making process are enabled by this middleware framework.	05/2010-06/2013	https://cordis.europa.eu/project/rcn/94446_de.html, https://cordis.europa.eu/result/rcn/173578_en.html
VITRUV	Vulnerability Identification Tools for Resilience Enhancements of Urban Environments	EU-FP7	Vulnerability Identification Tools for Resilience Enhancements of Urban Environments	05/2011-04/2014	https://cordis.europa.eu/project/rcn/98970_de.html
VMEWI3	Vehicle Mounted Early Warning of Indirect Indicators of IEDs	EDA	The objectives of this project is to focus on the detection of indirect indicators with forward looking camera systems. The technology demonstrator will be based on remotely operated unmanned ground vehicle (UGV) platforms with multi-camera head. The UGV platform will be controlled from a manned vehicle. The aim is to detect indicators of IED presence even while moving with a speed of at least 20-30 km/h (early warning capacity).	2017-2020	https://eda.europa.eu/news-and-events/news/2017/01/12/eda-programme-launched-to-improve-ied-detection

VoTeKK	Preparation for terrorist attacks, crises and disasters	National (Germany)	The goal of this project was to prepare the German healthcare system for disasters, crises and terrorist attacks. The intention was to perform continuous quality management on existing solutions and identify weak points. The project also sought to set up a disaster medicine online academy and other e-learning platforms.	06/2009-05/2012	https://www.sifo.de/files/Projektumriss_VoTeKK.pdf
VOX-Pol	Virtual Centre of Excellence for Research in Violent Online Political Extremism	EU Network	The aim of the VOX-Pol Network of Excellence (NoE) is the comprehensive exploration of the many varieties of Violent Online Political Extremism, its societal impacts, and responses to it. To this end, project partners combine complementary expertise from a range of disciplines (e.g. Communications, Computer Science, Criminology, Ethics, International Relations, Politics).	01/2014-12/2018	https://www.voxpol.eu/
V-SICMA	Sensitisation, assessment and action training on security measures in public transport companies as an illustration of critical infrastructures	National (Germany)	This project set out to conduct systematic research to identify action required from public transport company employees when confronted with risks and to develop effective training methods and systems, including interactive simulation (using 3D visualisation). The intention was to raise these employees' awareness of security risks and enable them to detect (terrorist) risks and take the appropriate action	02/2009-01/2012	https://www.sifo.de/files/SvV_600x800_V-SICMA.pdf
WIMAAS	Wide maritime area airborne surveillance	EU-FP7	The main aim of the WIMA2S project consists of developing key technologies to prepare the future for the operational use of Unmanned Aerial Systems (UAS), innovative mission aircraft and space assets, as key building blocks integrated in a System of Systems approach.	12/2008-11/2011	https://cordis.europa.eu/project/rcn/88640_de.html
XClanLab		ISFP	In case of an illicit bomb factory it is also very important that first responders know how to act in such a situation and how to be safe as well as what information to convey to the experts that are called upon. This project will develop a mobile application (app) for Android and IOS operated devices to meet these requirements.	in progress	https://xclanlab.eu/
XP-DITE	Accelerated Checkpoint Design Integration Test and Evaluation	EU-FP7	The aim of the XP-DITE project is to develop, demonstrate and validate a comprehensive, passenger-centred, outcome-focused, system-level approach to the design and evaluation of airport security checkpoints.	09/2012-07/2017	https://www.xp-dite.eu/, https://cordis.europa.eu/result/rcn/165960_en.html
	Non conventional enclosures for protection of critical buildings and facilities: Seismic and blast loads mitigation	National (Spain)			
	Real Time Identification: Decision Support Model	National (Netherlands)			
	CSI Assistant	National (Netherlands)			
SIS-COM-ISC	Integrated system for support and command of intervention teams in crisis situations	National (Romania)	The project "Integrated system for support and command of intervention teams in crisis situations" aims to develop an integrated system, comprising hardware, software and communication resources needed to assure the planning and coordination of missions in crisis situations. A subsystem will be developed for calculation of the explosion parameters in air, simulation, analysis and evaluation of the impact of shockwaves on buildings, simulation and evaluation of the effect of an explosion on persons and also an integrated system comprising communications and informatics destined for assurance of bidirectional information streams comprising video streams, physiologic and location data of the intervention team.	2018-2021	www.9sol.ro
PORDEX	Developing a unique solution for detecting explosive materials	National (Danmark)	The goal for the PORDEX project is to develop an efficient and safe solution for Explosive Ordnance Disposal (EOD) The method for detecting the explosives shall be: • Fast and reliable • Without touching potential explosive material • Remotely controlled if necessary	2019 - 06/2022	

BULLSEYE	A harmonized response to chemical and biological terrorism	European Internal Security Fund Police	The general objective of Bullseye is to further improve the knowledge and skills of all first responders in all EU member states on how to prevent terrorist attacks using CBRN agents and explosives by improving detection capabilities as well as on how to properly mitigate and respond in case of an emerging chemical or biological attack. The aim of the project is to realise: • Harmonised procedures for chemical and biological hazard for seven types of first responders in Europe • K9: Enhanced training facilities and training curriculum for explosive detection dogs.	04/2019 - 03/2022	https://www.bullseyeproject.eu/
MALL CBRN	Creation of CBRNE protection system for large area shopping malls		The project long-term goal is increasing safety of European Union society using daily the services of large-area shopping malls by creating comprehensive program of prevention and response to CBRNe threats	11/2019 - 10/2022	http://mall-cbrn.uni.lodz.pl/
PAS 97:2021	Screening Mail and Courier Deliveries		PAS 97 is the current comprehensive guidance on mail screening and security, produced by CPNI in collaboration with the British Standards Institution (BSI), and with the assistance of a range of stakeholders. It aims to assist organisations in assessing the risks they face from postal threats, and in implementing appropriate screening and security measures, either internally or outsourced.		https://www.cpni.gov.uk/screening-mail-and-courier-deliveries
INHERIT	INHibitors, Explosives and pRecursor InvesTigation	EU-H2020	INHERIT proposes to develop a multi-disciplined approach to intervene across multiple stages of the terrorism timeline. INHERIT has assembled a multi-faceted team with experience of all aspects of four important steps in this timeline. With a focus on explosive precursor chemicals, the team will work to develop technologies directed towards thwarting the ability of terrorists to exploit these materials for production of explosives.	06/2020 - 05/2024	https://cordis.europa.eu/project/id/101021330
Walleye	The world's first fully portable hand-held microwave imaging technology scanner	EU-H2020	The EU-funded Walleye project developed the world's first fully portable scanner with microwave imaging technology intended for the burgeoning security screening and security detection system markets	01/2019 - 04/2020	https://cordis.europa.eu/project/id/883809
ROXANNE	Real time network, text, and speaker analytics for combating organized crime	EU-H2020	The EU-funded ROXANNE project intends to combine new speech technologies, face recognition and network analysis to facilitate the identification of criminals. Specifically, ROXANNE will develop a platform that will increase agencies' capabilities via voice recognition, language and video technologies.	09/2019 - 12/2022	https://cordis.europa.eu/project/id/833635
EXTORT	Anthropologies of Extortion	Horizon Europe	Systematic research on and explanatory models for the apparent expansion and routinisation of extortion in everyday life (including cyber-extortion) are currently lacking. Timely, the project sets up extortion as an object of anthropological inquiry and charts the first comprehensive cross-cultural account of extortion in social life across South and East Asia, the Americas, Africa and Europe.	01/2021 - 12/2025	https://cordis.europa.eu/project/id/884839
ePOOLICE	Detecting organised crime	EU-H2020	Organised crime is expanding its methods and range of activities, while also becoming less localised and more virtual. European authorities believe that combating such crime requires a strategic monitoring and warning system. The EU-funded 'Early pursuit against organized crime using environmental scanning, the law and intelligence systems' (EPOOLICE) project aims to develop such a system.	01/2013 - 12/2015	https://cordis.europa.eu/article/id/165975-detecting-organised-crime
CRIMGOV	Production, Trade and Governance: a New Framework for the Understanding of Organized Crime	Horizon Europe	The project will study a broad range of organized crime in depth: local cybercrime production hubs in Europe, the international trade of drugs from Colombia to Europe, the emergence of criminal governance inside and outside prisons.	01/2021 - 10/2026	https://cordis.europa.eu/project/id/101020598
AIDA	Artificial Intelligence and advanced Data Analytics for Law Enforcement Agencies	Horizon Europe	The EU-funded AIDA project is focussing on cybercrime and terrorism by approaching specific issues related to law enforcement agencies (LEAs) using pioneering machine learning and artificial intelligence methods.	01/2020 - 02/2023	https://cordis.europa.eu/project/id/883596

CounteR	Privacy-First Situational Awareness Platform for Violent Terrorism and Crime Prediction, Counter Radicalisation and Citizen Protection	Horizon Europe	In order to support the fight against radicalization and thus prevent future terrorist attacks from taking place, the CounteR project will bring data from disperse sources into an analysis and early alert platform for data mining and prediction of critical areas (e.g. communities), aiming to be a frontline community policing tool which looks at the community and its related risk factors rather than targeting and surveilling individuals.	01/2021 - 04/2024	https://cordis.europa.eu/project/id/101021607
UNCOVER	Development of an efficient steganalysis framework for uncovering hidden data in digital media.	Horizon Europe	Criminals and terrorists use more and more data hiding methods (steganography) for concealing incriminating information in innocent-looking digital media files such as images, video, audio, and text files. UNCOVERs main objective is to fill existing gaps in the ability of Law Enforcement Agencies (LEAs) for detecting the presence of such hidden information (i.e. steganalysis)	05/2021 - 04/2024	https://cordis.europa.eu/project/id/101021687
INFINITY	IMMERSE. INTERACT. INVESTIGATE	EU-H2020	e fight against cybercrime, terrorism and other hybrid threats hinges on technological and policy innovation. The EU-funded INFINITY project will couple virtual and augmented reality innovations, artificial intelligence and machine learning with big data and visual analytics. Its aim will be to deliver an integrated solution to revolutionise data-driven investigations.	01/2020 - 05/2023	https://cordis.europa.eu/project/id/883293
LAW-GAME	An Interactive, Collaborative Digital Gamification Approach to Effective Experiential Training and Prediction of Criminal Actions	Horizon Europe	the aim of the project is to train police officers' on the procedure, through gamification technologies in a safe and controlled virtual environment. Essential tasks during the creation of LAW-GAME serious game are to virtualise and accurately recreate the real world.	09/2021 - 08/2024	https://cordis.europa.eu/project/id/101021714
APPRAISE	fAcilitating Public & Private secuRity operAtors to mitigate terrorIsm Scenarios against soft targEts	Horizon Europe	APPRAISE aims to build on the latest advances in big data analysis, artificial intelligence, and advanced visualisation to create an integral security framework that will improve both the cyber/physical security and safety of public spaces by enabling a proactive, integrated, risk-based, and resilience-oriented approach. This framework will be designed to support the secured private-public collaboration and optimise the coordination of operations involving private security staff, private operators, and law enforcement agencies.	09/2021 - 08/2023	https://cordis.europa.eu/project/id/101021981
RISEN	Real-tIme on-site forenSic tracE qualificatioN	EU-H2020	he aim of the EU-funded RISEN project is the development of a set of real-time contactless sensors for the optimisation of trace detection, visualisation, identification and interpretation on site. Data will be processed in real time and sent to a 3D augmented crime scene investigation system to produce an interactive 3D model of the scene with position and labelling of traces and relative analytical results.	06/2020 - 06/2024	https://cordis.europa.eu/project/id/883116'
AWARE	Advanced Face Recognition and CroWd Behavior Analysis for Next GeneRation VidEo Surveillance	EU-H2020	The AWARE project proposes an innovative solution that analyses crowd behaviour, achieves high processing speed, and is cost-effective.	09/2019 - 02/2020	https://cordis.europa.eu/project/id/876945
	Best Practices for Preventing ATM Gas and Explosive Attacks		International minimum security guidelines and best practices		https://www.atmia.com/files/Best%20Practices/Preventing%20Gas%20and%20Explosive%20Attacks%20%E2%80%93%20Version%202.pdf
	Recommended Physical ATM Security Guidelines		ATMSWG		https://www.link.co.uk/media/1181/best-practice-for-physical-atm-security.pdf
	EU Guidance on Operating for Explosive Detection Dogs in Public Spaces		The document is a collection of best practices. It does not provide an exhaustive list of all explosive detection dog (EDD) procedures, but seeks to identify the key guiding principles that any explosive detection dog team should observe during operational deployments.		https://ec.europa.eu/newsroom/pps/document.cfm?doc_id=71619

IDT	The IntelliDogTrainer, a new high throughput training device to train high level security dogs		IDT will be an industrially manufactured product invented by TSE and it is the only system on the market allowing automated 24/7 behavioural testing of 5-10 dogs in a home-cage setting. IDT will train dogs, will support certification and re-certification and will result In high performing dogs at large scale.	08/2018 - 01/2019	https://cordis.europa.eu/project/id/816148/de
RIBS	RESILIENT INFRASTRUCTURE AND BUILDING SECURITY	EU-FP7	The RIBS-project supports the design of effective and viable integrated security measures aimed at protecting infrastructures without impacting on their business dynamics. In a global context where national interests are increasingly interrelated, the most vulnerable infrastructures in Europe, and particularly the most critical ones, are primary targets for terrorists. Attacks, carried out under a national, political, or religious banner, now strike regularly in our cities, causing deaths, damage and disruption on an unprecedented scale. In the past seven years alone, 1300 terrorist incidents have taken place on European soil. The RIBS project will deliver more effective and viable security measures by supporting a design process that integrates a broader understanding of the environment (and the contextual factors such as human elements) within which these measures are meant to be implemented. The particular objectives of the project include: • a set of functional and non-functional requirements that will drive an effective security system design process. • a set of protection measurement techniques that can be used to assess the level of protection offered by candidate security products proposed to be implemented in buildings and infrastructures. This work will be carried out for a range of security systems aimed at securing buildings against hostile reconnaissance, intruders and hazardous attack (including chemical, biological and explosive). The RIBS-project will derive a scientific method for security system engineering design that can be challenged and improved over the years, similarly to other areas of engineering and physical sciences. • Phase 1: Study of a 'live' building and its 'eco-system', its protection measures, and threats; and integration of these elements into a single multi-layer model. • Phase 2: Identification of vulnerabilities through incident analysis and protection-measures analysis. • Phase 3: Development of design requirements.	11/2010-10/2013	RESILIENT INFRASTRUCTURE AND BUILDING SECURITY	RIBS Project	Fact Sheet	FP7	CORDIS	European Commission (europa.eu)

EVACUATE	A holistic, scenario-independent, situation-awareness and guidance system for sustaining the Active Evacuation Route for large crowds	EU-FP7	The dynamic capture of situational awareness concerning crowds in specific mass gathering venues and its intelligent enablement into emergency management information systems, using smart communication devices and spaces is critical for achieving rapid, timely guidance and safe evacuation of people out of dangerous areas. Humans could be overwhelmed by fast changes of potentially dangerous incidents occurring at confined environments with mass-gathering. They could fail to make objective decisions to find their way to safety. This condition may lead to mass panic and make emergency management more challenging. In eVACUATE, the intelligent fusion of sensors, geospatial and contextual information, with advanced multi-scale crowd behaviour detection and recognition will be developed. The structured fusion of sensing information with dynamic estimated uncertainties on behaviour predictions will advance eVACUATE crowd dynamic models; and virtual reality simulations of crowds in confined environments. A service oriented Decision-Support System shall be developed to dynamically distribute on-demand evacuation information to emergency management actors as the crisis unfolds. Decision-makers at the command posts, first responders, front-line stewards and volunteers receive real-time situation aware information of updated evacuation strategies using robust and resilient eVACUATE information and communication infrastructure. Smart spaces of electronic, audio and other mobile devices shall be connected to the integrated system to provide safer evacuation routings for people. The eVACUATE system performance and scalability will be validated in four distinct scenarios involving incidents with large crowd at various venues with the requirements of evacuation time reductions and increases of safety and security. These are: 1) Underground stations in Bilbao; 2) Real Sociedad Footbal Stadium in San Sebastian, 3) Athens International Airport and 4) a STX Cruiseship.	04/2013-05/2017	https://cordis.europa.eu/project/id/313161
ALDrone	A humanitarian drone for the rapid detection of landmines and other explosive remnants of war	H2020	To meet the need for a fast way to detect landmines an Anti-Landmine Drone (ALDrone) was created. A small, lightweight drone that detects landmines using a multispectral camera to spot the erosion created by the decomposition of the chemical elements in a mine.	09/2015-12/2015	https://cordis.europa.eu/project/id/697330
TERASEC	THz imaging technology for public security	H2020	The EU-funded TERASEC project developed to the market a novel, incomparable security scanner device of unique performance. It should fulfill all regulatory compliances. The scanner uses advanced and harmless THz waves thanks to superconducting and ferromagnetic materials that enable great sensitivity, fast response time and low noise-equivalent power.	06/2020-05/2022	https://cordis.europa.eu/project/id/899315
ENTRANCE	EfficieNT Risk-bAsed iNspection of freight Crossing bordErs without disrupting business	H2020	The EU-funded ENTRANCE project aims to develop and validate a comprehensive user-based toolbox for the risk-based non-intrusive inspection of cross-border freight movements, particularly at the EU Customs Union borders. The aim of this toolbox is to enhance the capabilities of border security practitioners, shielding against a wide range of dangerous and illicit materials with minimum disruption in the cross-border flow of goods. The ENTRANCE toolbox will be validated at the EU Customs Union borders by five practitioner-led field trials that will be chosen for their relevance, strategic position and feasibility.	10/2020-09/2023	https://cordis.europa.eu/project/id/883424
PARSEC	Parcel and Letter Security for Postal and Express Courier Flows	Horizon Europe	Being able to detect threats and illicit goods in postal and express courier flows is vital to the security of the EU. However, this area faces key challenges such as the lack of technology capable of screening volumes of goods efficiently. The EU-funded PARSEC project will develop and test three next-generation non-intrusive detection technologies – a multi-energy photon counting detector, neutron-induced gamma-ray spectroscopy, and X-ray diffraction – and combine them into a detection architecture for detection accuracy, speed, and reliability. This will help stop the abuse of postal and express courier flows for criminal and terrorist purposes.	10/2022-09/2025	https://cordis.europa.eu/project/id/101073963

S4AllCities	Smart Spaces Safety and Security for All Cities	H2020	Smart cities need to ensure a secure and safe physical and digital ecosystem for the well-being of EU citizens. The EU-funded S4AllCities project aims to make cities' infrastructures, services, ICT systems and Internet of Things more resilient while promoting intelligence and information sharing amongst security stakeholders. To achieve this, it will integrate advanced technological and organisational solutions into a market-oriented, unified cyber–physical security management framework. The system will focus on risk-based open smart spaces security management, cybersecurity shielding, suspicious activity, behaviour tracking, the identification of unattended objects, the real-time estimation of cyber–physical risks in multiple locations and measures activation for effective crisis management. This work will play a role in promoting good safety and security practices in European cities.	09/2020-12/2022	https://cordis.europa.eu/project/id/883522
SAFE-CITIES	riSk-based Approach For the protEction of public spaces in European CITIES	Horizon Europe	Over the past couple of decades, numerous terrorist attacks have taken place in Europe. Although serious attacks are no longer a frequent occurrence, the threat is real and it does persist. A terrorist incident can occur suddenly in any public space, increasing feelings of insecurity and reducing trust in fellow citizens and institutions. In this context, the EU-funded SAFE-CITIES project will deliver and demonstrate a security and vulnerability assessment framework. A modelling and simulation platform will support its implementation and strive to ensure excellence in the protection of public spaces. The solution will enable the simulation of complex scenarios of attacks and crowd responses in any space within a realistic virtual 3D environment. This will allow end users to comprehensively assess risk and vulnerability and support the engagement and cooperation of public and private actors.	11/2022-12/2024	https://cordis.europa.eu/project/id/101073945
MKD	A drone to clear minefields	H2020	The project proposes a new system of landmine detection based on unmanned aerial vehicles (UAVs). The Mine Kafon Drone system is a safe, reliable, efficient, fast and cheap solution. It maps and scan entire areas to find the mines and then places a small detonator on every detected mine.	01/2020-06/2020	https://cordis.europa.eu/project/id/887195
COSMIC	CBRNE Detection in Containers	H2020	COSMIC system plans to bridge the major security gap for fast inspection of large number of containers and vehicles in sea port and in crossing borders for CBRNE materials. COSMIC's technology can be adapted also to air containers. COSMIC proposes a novel technological approach for the detection of CBRNE materials hidden in shipping containers. COSMIC project includes the research, design and implementation of a three stage (primary, secondary, focused manual inspection) detection system using new set of innovative sensors	10/2018-09/2021	https://cordis.europa.eu/project/id/786945
SHUTTLE	Scientific High-throughput and Unified Toolkit for Trace analysis by forensic Laboratories in Europe	H2020	the SHUTTLE project intended to run a Pre-Commercial Procurement (PCP) action between forensic institutes across Europe to mitigate these technical and financial barriers and jointly carry out the procurement of the necessary Research and Development (R&D) activities to develop a machine+toolkit that should integrate different tape analysis tools to automate the routine part of the work of trace evidence examiners and, eventually, strengthen further judicial and police cooperation.	05/2018-10/2022	https://cordis.europa.eu/project/id/786913
COPKIT	Technology, training and knowledge for Early-Warning / Early-Action led policing in fighting Organised Crime and Terrorism	H2020	The COPKIT project addresses the problem of analysing, preventing, investigating and mitigating the use of new information and communication technologies by organised crime and terrorist groups. This question is a key challenge for policy-makers and LEAs due to the complexity of the phenomenon, the quantity of factors and actors involved, and the great set of criminal and terrorist technological activities in support of OC and terrorist actions. It is a clear VUCA world effect (volatility, uncertainty, complexity and ambiguity).	06/2020-09/2021	https://cordis.europa.eu/project/id/786687

PROPHETS	Preventing Radicalisation Online through the Proliferation of Harmonised ToolkitS	H2020	PROPHETS will look at redefining new methods to prevent, investigate and mitigate cybercriminal behaviours through the development of a coherent, EU-wide, adaptive SECURITY MODEL, built upon the interplay of the human factors within the new cyber ecosystem and capable of addressing the four fundamental dimensions at the core of the phenomenon: 1. early identification of security threats; 2. investigations within a new public-private governance; 3. Increased complexity of the response due to the expansion of the security perimeter towards new societal fields and the emergence of challenging jurisdictional problems; and, last but not least, 4. perception of security and freedoms among citizens, which requires a new communication strategy for LEAs and security policy makers.	05/2018-06/2021	https://cordis.europa.eu/project/id/786894
LOCARD	Lawful evidence collecting and continuity platform development	H2020	The EU-funded LOCARD project aims to procure a comprehensive platform that permits the storage of digital evidence data and ensures appropriate chain custody in juridical work. LOCARD will employ a 'Trusted Execution Environment' to guarantee privacy and provide access to a range of digital evidence.	05/2019-07/2022	https://cordis.europa.eu/project/id/832735
EVACUATION	Testing communication strategies to save lives in emergency evacuation	H2020	This project aimed to: 1.Identify which risky behaviors occur in emergency evacuations and underlying causes 2. Use models to identify communication strategies that improve evacuation time and survival 3 Test communication strategies for improving evacuation time and survival in experiments	05/2018-07/2020	https://cordis.europa.eu/project/id/748647
ANITA	Advanced tools for fighting oNline Illegal TrAfficking	H2020	ANITA aimed to design and develop a novel knowledge-based user-centred investigation system for analysing heterogeneous (text, audio, video, image) online (Surface Web, Deep Web, DarkNet) and offline content for fighting illegal trafficking of drugs, counterfeit medicines, NPS and firearms	05/2018-10/2021	https://cordis.europa.eu/project/id/787061
FASTER	First responder Advanced technologies for Safe and efficienT Emergency Response	H2020	The EU-funded FASTER project will examine the impact and the role first responders can have in cases of disasters. It will take into consideration the entire lifecycle of emergency preparedness and response, including the planning, logistical support, maintenance and diagnostics, training and management. The ultimate aim of the project is to further the European Union's ability to respond to emergencies.	05/2019-04/2022	https://cordis.europa.eu/project/id/833507
Smart-Trust	Smart Trust: Secure Mobile ID for Trusted Smart Borders	H2020	Smart-Trust introduces a new technological enabler for Mobile ID which drastically increases the reliability and trust levels of identity verification at European borders, thus increasing the security of member states. The platform is compatible with a seamless self-service experience based on biometrics on the move which provides freedom of movements to citizens while ensuring their privacy safeguarded according to Privacy by Design principles.	01/2018-03/2020	https://cordis.europa.eu/project/id/778571

Appendix 2: Technologies

Measure	Concept/ principle	Technology	Details
Protection	Barriers	Gates & Fences	Gates: Pedestrian, turnstiles, vehicle gates; Fences: Picket, concrete, welded wire-mesh, chain-link, palisade fence, barbed and razor wire, electric
		Vehicle barriers	Retractable barriers: Road blocker, bollard, raptor, crash gate barrier, arm and spike barrier; Fixed barriers: Bollard, Metal/concrete barriers, planter, temporary barriers
	Building components	Door	different materials, types of construction e.g. explosive resistant
		Wall	Materials based on fibre composites, Ceramic pellets between two walls
		Window	Roller shutter, Burglary proof glass, Bulletproof glass, Foils
		Building design	regulation, guidelines, handbooks of reference
	Shielding/ Protection of blast	Vehicle protection	blast resistence by design, regulations..
		Body protection	blast suit (EOD), overalls of different materials, kevlar, shields
		Bomb shielding	blast suppression blankets/wraps, Blast shield wall or containment tank
	Neutralisation/ Destruction/ Manipulation	Neutralisation of IED	water jet disrupters, high power laser, …
		Implements	telescopic manipulator, hook and line kit
		Neutralisation of Vehicle	destructive or non-destructive
		ECM Electronic Counter Measures	Methods to block electronic signals
Surveillance	Video (CCTV)	Cameras & lenses	Cameras: different sensors, visible light, video, IR, thermal cameras…; Lenses: different types
		Supplies	Monitors, Scene illumination, Transmission links/networks, Integrated products as APNR cameras
		Multiplexers, switchers	Camera switchers, Quads & multiplexers
		Image storage	Digital video recorders, Network video recorder (NVR), IP SAN (storage area network), Optical disk recorders, Mobile DVRs
		Video analytics	Video management software, Detection, recognition e.g. numberplate, tracking, satellite imagery
Detection & Analytics of Explosives	Bulk (visible amount)	x- & g-Ray	Single/dual/high energy, transmission, Multi-view/computed tomography (CT), backscatter, X-ray Diffraction, x-ray computed tomography, dielectric measurements
		Neutrons	Fast neutron analysis (FNA), Pulsed FNA (PFNA), Thermal neutron analyses (TNA), and PFTNA
		Electromagnetic	NQR, NMR, ESR
		Electromagnetic Imaging	Microwave, Terahertz, IR, Raman, Radar, Magnetic resonance imaging (MRI)
	Trace (not visible amount)	Optical & spectroscopic	IR, Raman, spatially offset Raman (SORS), LIBS/Plasma, PF-LIF, Flame Photometry, UV-VIS Fluorescence, chemiluminescence
		Vapour Detection	Higv-Volume sampling or direct sampling with "sniffer" devices
		Electronic & Chemical	IMS, MS, GC, electrochemical methods, Catalytic, Photo Ionization (PID), Thermal and Electrical Conductivity Semiconductor, Electronic Nose, thermo redox
		Swabs and chemical test kits	Colour change reactions
		Chemical sensors	sensor array
		Biosensor	Dogs (& bees, rats)
	Analytical Instruments (Lab)	Chromatographic	HPLC, GC with different detectors (DAD, MS, RI or FID, TCD, MSD, Capillary electrophoresis
		Spectroscopy	UV/Vis, NMR, IR, Raman, ICP, EA, XFR
		Mass spectrometry	ToF-MS, Q-ToF-MS, Q-MS, QQQ-MS, Ion-Trap-MS & different ionisation types
Other Detection	Seismic detectors	Seismometers	Instruments that react to ground noises and vibrations caused, for example, by explosions.
	People Screening	Metal detectors	Walk-through metal detectors, handheld metal detectors, Other metal detectors and magnetometers
		Portals	Security scanners and walk-by imagers active millimetre-wave, Security scanners and walk-by imagers active millimetre-wave, IR imaging portals, Backscatter x-ray imaging portals, Low-dose x-ray transmission imaging
		Biometrics	Fingerprints, Face Recognition, Iris diagnostic, DNA,…
	Screening of other things	Various tools	Detection of electronic devices, Reconstruction of Crime scene, visual inspection

Other Technology	Security/Crisis Management	Various developed Systems	E-Learning, active or passive (simulation) training for FRs, Communication, systems in general, software tools, guides for post-plast behaviour, (online) platforms for information sharing, Apps
	Inhibition	juridical	regulations
		technical	Marker
	Drones	UAV	Audio/Video/other sensors
		UGV/Robots	Audio/Video/other sensors

Appendix 3: Technology one-pagers

Appendix 3 provides comprehensive summarises of individual techniques in the form of one-pagers that indicate product type, overview of characteristics, application- and market aspects, and a cost-estimation.

Products types:

Personal Protective Equipment (PPE)

Common Characteristics - Overview:

Personal protection from pressure and debris from an explosion.

Application aspects:

The PPE, otherwise known as a bomb suit, is a heavy suit of body armor designed to withstand the pressure released from an explosion and to provide protection from any debris produced. Modern bomb suits include layers of Kevlar®, ballistic plating, and foam placed strategically throughout the suit to provide the wearer maximum protection. Advanced helmet models also have built-in headphones and a microphone, and the ability to transmit signals (e.g., radio).

Market aspects:

Commercial product.

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
PPE	2	M - H	React

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:

GARANT Schutztechnik GmbH; Med-Eng Holdings ULC; United Shield International; Arcon Partner LTD; NP Aerospace, Inc.; Kejo Limited Company; Point Blank ENTERPRISES, INC.; Westminster Group Plc;

Research Institutes/Universities active in the field:

University of Virginia, Charlottesville, USA; New Jersey Institute of Technology, Newark, NJ, USA; , Texas A&M University, College Station, TX 77843, United States; Clemson University, Clemson, SC, 29634, USA; University of Cambridge, Trumpington Street, Cambridge CB2 1PZ, UK; The University of North Carolina at Charlotte, Charlotte, NC 28223, United States; University of Illinois at Urbana-Champaign, Urbana, IL, 61801, USA;

	Status 22.01.2023 Version 1.2

Products types:

Blast shield wall (BSW), Blast containment tank (BCT), Man-Portable Mitigation Device (MITIED), Ballistic protection kit/ Raptor, Bomb container

Common Characteristics - Overview:

BSW is a large sheet of woven steel rope mesh. It can be put between the IED and the building/area/personnel that requires protection. It protects against blast and fragments. 3x3 m and 600-950 kg. The **BCT** and **MITIED** are placed over an IED to reduce the blast overpressure and the fragments from the IED if it detonates. BCT is a basket shaped device made of woven steel rope. The **Raptor** protects first responders and innocent bystanders against fragments generated during IED detonation. A **bomb container** is usually a cylindrical assembly that consists of packed woven fibers combined with flame retardant bonder that is designed to withstand the blast and fragments from explosive devices.

Application aspects:

A **BSW** can used both for pre-emptive measures and in situations when a threat has been identified. It does not limit the possibilities for IED neutralizing measures. Needs a trailer, or large van to be moved, and a trolley or lifting system to be moved into position.

If a suspicious object is encountered it might be placed in the **BCT** until it can be dealt with. BCT´s could be stored on convenient locations. MITIED is a lightweight composite container (44-49 kg) that can be placed over an IED to reduce the blast overpressure and the fragments from the IED if it detonates.

The Raptor provides in case of a threat be a safe place for up to three people by lining up shields triggered by a gas generator (< 1sec). This Protection kit is transportable (80 kg), contained in wheeled box (large luggage size). The drum of a **bomb container** needs to safely roll over the suspect object without touching or operating it. Bomb containers are specially designed to help the bomb squad to analyze the suspect object without removing it – through the walls – using x-ray equipment.

Market aspects:

BSW, BCT and MITIED have been developed and tested in the computational tool LS-Dyna during the ENCOUNTER project. BCT was also evaluated in real tests. Raptor achieved a TRL 6 in the SUBCOP project. Bomb container are commercial products.

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
BSW	1	M	M
BCT	1	L, M	M
MITIED	1	M	M
Raptor	1		M
Bomb container	2	M	M

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:

Tamar Israeli Advanced Quarrying Co Ltd; Ideal Supply Inc.; TechnoKontrol; InterDam B.V.; Blast & Ballistic Protection Limited; T.M. INTERNATIONAL, LLC; BLAST DEFLECTORS, INC.; LINE-X; SJH Projects Ltd; Netline Communications Technologies Ltd.;

Research Institutes/ Universities active in the field:

FOI Swedish Defence Agency; Ingeniería de Sistemas para la Defensa de España, S.A.; The University of Sheffield UK; Centre for Security and Society CSS Albert-Ludwigs-Universität Freiburg; DHS, USA;

Products types:

Architectural design, Compartmentalisation and redundancy, Criteria to generate blast protection sectors in infrastructures and buildings, Catalogue of Materials, Criteria to generate blast protection spaces in rooms of buildings or in open air infrastructures, Infrastructure design legislation

Common Characteristics - Overview:

In order to achieve a higher level of protection through the design of buildings, various aspects of the design process need to be considered. Infrastructure design legislation should set levels of protection for infrastructures to be achieved depending on their vulnerability. Criteria for the formation of explosion protection sectors in buildings and infrastructures depending on the levels of protection and their vulnerability must be established. Compartmentalisation and the correct choice of materials used should be applied to improve the ability of facilities to withstand explosions and protect people.

Application aspects:

The design decisions relate to every part of the building, from the overall layout of a building and facade construction to the type of load-bearing structures and choice of connection techniques. The measures cannot be listed individually, but must be applied specifically to each building where protection is part of the design process. When considering the protection of functional infrastructure, important functions of this infrastructure can be identified and arranged/constructed to create redundancy. For cases where separation by distance is not possible, measures to increase protection between two redundancy objects, such as blast-proof walls, can be used to create two compartments within the same area that is difficult to destroy with only one IED. Blast risk and collateral effects must be assessed for buildings and infrastructure depending on their vulnerability. Location, environment, criticality, use, number of users, choice of construction material conditions the external and internal distribution of buildings and infrastructures. Criteria for the development of specific rules, effective assessment and guidelines for the design of protective sectors are necessary to ensure that the impact of explosions in each sector is limited according to the influencing factors mentioned. The development of explosion protection sectors, which are included in the design rules, increases the passive response in the event of an attack on a building or infrastructure.

Market aspects:

Criteria to generate blast protection sectors in infrastructures and buildings: TRL 1-2. Catalogue: TRL 1
Criteria to generate blast protection spaces: TRL 3. Infrastructure design legislation: TRL 2-3 (In Europe, in other countries like USA and Israel TRL 9).

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
Building design	1-2	H-VH	Mitigate

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:

American Society of Civil Engineers, USA; Werner Sobek AG, B.A.W. ARCHITECTURE; Baker Engineering and Risk Consultants, Inc.; Lindner Group KG; Module X Solutions; Temet International Oy Ltd;
FORTRESS Protective Buildings; Air Sea Land Group; Speed Space;

Research Institutes/Universities active in the field:

Fraunhofer Institute for High-Speed Dynamics, Ernst-Mach-Institut, EMI, Freiburg Germany; University of Illinois at Urbana-Champaign, RISK Research Center, University of the Bundeswehr Munich, Neubiberg, Germany;

Products types:

Blast resistant door

Common Characteristics - Overview:

To prevent the blast effects from spreading between the rooms, blast resistant doors may be fitted to contain the effects from the blast.

Application aspects:

If the location of operation is e.g. a passenger safety checkpoint, an efficient flow of people is often desired, and a blast safety door may reduce the flow of people passing the checkpoint. Blast resistant doors are heavier than normal doors.

Market aspects:

Various explosion-proof doors are available, which can be adapted to the respective requirements depending on the working environment and application.

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
Blast resistant door	2	M-H	M

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:

Architectural Armour Ltd; Heinen Doors; Buchele GmbH; SÄLZER GmbH; VETROTECH SAINT-GOBAIN INTERNATIONAL AG; Schüco International KG; Protec Industrial Doors B.V.; Jansen AG; HAVERKAMP GmbH; InterDam B.V.;

Research Institutes/Universities active in the field:

Fraunhofer Institute for High-Speed Dynamics, Ernst-Mach-Institut, EMI; School of Mechanical Engineering, Chung-Ang University, 84, Heukseok-ro, Dongjak-gu, Seoul; TNO, Netherlands Organisation for Applied Scientific Research;

Products types:

Disruption of electronic circuits by HPM, Blocking of electromagnetic signals, ECM - jamming device

Common Characteristics - Overview:

HPM disturbs or destroys an electronic circuit (in an IED trigger system) via high power microwaves (HPM). **Blocking** and **jamming** block or cancel out incoming radio or telecommunication signals, primarily to counteract remote initiation attempts.

Application aspects:

HPM can be used to disrupt/destroy integrated electronic circuits in the IED. Distance range: 5-30 m. Smaller systems have the option of being remotely controlled and transported to the IED on a robot. From a forensic point of view, the neutralisation method will leave everything intact except the electronic circuits. There is a possibility that HPM can detonate the IED. Not for mechanically timed triggers. HPM will disrupt/destroy all electronic circuits in the area where its field strength is strong enough. One cannot be sure that the IED is neutralised and even though the trigger is deactivated, the main charge may still be sensitive.

Blocking is done by a mesh fabric enclosure called a "Faraday cage". It is important to ensure that the IED is completely covered, as signals can penetrate even through a tiny hole.

Radio jamming creates an overload of the signal with the aim of "drowning out" the trigger signal. A loss of function of the communication may occur. Interfering with licensed radio frequency bands requires a permit.

Market aspects:

HPM: More testing is needed to determine safe operating levels and required field levels to destroy the IED trigger. Approx. 100 triggers have been tested and results indicate that HPM works as intended. TRL 4 (ENCOUNTER).

Blocking: TRL 1 (SUBCOP)

Jamming: Commercial systems are available in different sizes, and for different applications. From large military systems transported on vehicles to man-carried pocket devices. TRL 8.

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
HPM	1	M	M
Blocking	1	L	M
Jamming	2	M-H	M

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:

Military; THALES Group; Scopex; AVANTIX; Albrecht Telecommunications; COJOT Oy; Israel Aerospace Industries, IAI; Allen-Vanguard Corporation; Rohde & Schwarz;

Research Institutes/Universities active in the field:

FOI Swedish Defence Agency; Ingeniería de Sistemas para la Defensa de España, S.A.; The University of Sheffield UK; American Military University, Charles Town, United States;

Products types:

Blast-resistant gates/fences

Common Characteristics - Overview:

Blast-resistant gates/doors are essential for sensitive infrastructures such as embassies, ministries or parliaments. Lightweight gates equipped with "energy absorbing systems" have better operational performance than the traditional costly and bulky design.

Application aspects:

The requirements for a gate or fence depend on the application. Different application scenarios require different levels of security. The behaviour of the gate/fence depends on the exact circumstances of the explosion.

Market aspects:

Solutions available for different end-user and applications.

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
Blast resistant gates	1-2	M-H	M
Blast resistant fences	1-2		M

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:

Madoor System; Architectural Armour Ltd; Heinen Doors; VETROTECH SAINT-GOBAIN INTERNATIONAL AG; Invicta Durasteel;

Research Institutes/Universities active in the field:

Institute of Structural Analysis, Poznan University of Technology; Cranfield University UK; Defence Academy of the United Kingdom; Faculty of Engineering, Ain-Shams University, Egypt;

Products types:

High power laser IED neutralization, Liquid Shaped Charge (LSC) with increased stand-off, Barrel disruptor with improved stand-off distance, EOD Robots/ Unmanned Ground Vehicles (UGVs), Projected water disruptors, TCV - Total containment vessel

Common Characteristics - Overview:

High power laser neutralizes IEDs at long stand-off distances by thermal effects. The tool works by slowly cooking off the explosive main charge. Employed laser has a power between 1 kW and 10kW. **Barrel disruptor, water disruptors** and **LSC** disrupts an IED by producing an accelerated water jet whereby LSC can by operated from a stand-off distance. **EOD Robots** inspect Improvised Explosive Device (IED) with the operator at safe distances. **TCV** is used to destruct an IED by initiation under controlled conditions by using a hermetically sealed, blast withstanding container

Application aspects:

High power laser has possible risks including blast effects and fragment formation have to be investigated. High power laser will be harmful to eyes and skin. It is possible that the laser may cause certain explosives to explode. Due to its size it currently needs to be incorporated into a trailer. Needs clear line of sight.
The LSC is compact and can be carried by a single person or a robot. It has an outer diameter of 100 mm and weighs 1 kg. Could preserve forensic evidence. Only for suspected or identified IEDs, with known charge sensitivity an only for small IEDs. Can penetrate steel pipe bombs. There is a risk to initiate the charge. Barrel disruptor can penetrate simpler backpacks and bags. Requires line of sight. The UGVs can be equipped with sensors to remotely monitor the environment (electronics, digital video transmission, camera, x-ray systems). Projected water disruptors can be directional, such as the BootBanger; or omni-directional, an example being the Bottler. TCV requires a sturdy blast container with strong ventilation and sealing systems.

Market aspects:

High power laser: TRL4-TRL5 at the end of ENCOUNTER. **LSC:** TRL 4 - TRL 5. Tested on confined and unconfined IEDs in different scenarios. (ENCOUNTER). **Barrel disruptor:** 30 tests were performed in ENCOUNTER. TRL 4. **EOD Robot, water disruptors** and **TCV:** Commercial products.

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
High power laser	1	M-H	R
LSC	1	M	R
Barrel disruptor	1	M	R
EOD Robot	2	M-H	M
Water disruptors	2	M-H	M
TCV	2	H-VH	M

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:

Military; HYDROPROCESS®; SCOPEX; THALES Group;

Research Institutes/Universities active in the field:

FOI Swedish Defence Agency; Ingeniería de Sistemas para la Defensa de España, S.A.; The University of Sheffield UK; Fraunhofer Institute for High-Speed Dynamics, Ernst-Mach-Institut, EMI, Dept. Impact Physics; Stanford University, Stanford, CA, United States; Explosives Center at Los Alamos National Laboratory, USA; Centre for Security and Society CSS Albert-Ludwigs-Universität Freiburg; University of Applied Sciences Velika Gorica, Velika Gorica, Croatia;

Products types:

Autonomous tool for removing vehicles - AVERT

Common Characteristics - Overview:

To remove manned or unmanned vehicles from an area.

Application aspects:

To remove vehicles near the EOD/IED device and make a free path in order to neutralize the threat. The task is done, automatically or remotely, removing operators from the danger area. It consists of 4 small platforms with electric wheels that is able to lift the vehicle and move it to another place. They are mounted on a towed structure with approximately 130x100x50 cm and a weight of 300 kg.

Market aspects:

TRL 6. Full demonstration had been carried out in march 2015. See AVERT Final Report Section 4.1 Combined (Issue 2 -28 July 2015).

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
AVERT	1	M-H	R

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:

Research Institutes/Universities active in the field:

Idus Consultancy Ltd; Bernd Siegfried Willy Birkicht; Züricher Hochschule für Angewandte Wissenschaften; Dimokritio Panepistimio Thrakis; Marshall Sdg Ltd; Force Ware Gmbh;

	Status 26.01.2023	Version 1.1

Products types:

Bollard, Hesco barrier

Common Characteristics - Overview:

To selectively limit access for vehicles to certain locations during selected time frames.

To limit access, reduce observability and to absorb blast effects from a compound or other establishment.

Application aspects:

In many places, however, it is difficult or even undesirable to limit access to the public. Concerning vehicles, there is in many cases a greater acceptance for limiting vehicles' access to certain zones. One method of doing this is utilizing bollards that fences an area so that no vehicles can pass, without restricting access to pedestrians. This method can possibly keep any VBIED (vehicle-borne IED) at a safe distance from any establishment or building that is subject to protection. Many available bollard types are retractable and extendable. With this feature, access availability can be controlled based on time of day, on different events or similar time aspects. The bollards could also be extended in cases of increased threat levels, during detected (ongoing) terrorist actions, or after a performed attack to limit any possible subsequent attacks. Note: Bollards (or similar rigid structures) are often considered a tool for reducing the impacts of vehicle-as-a-weapon (VAW) attacks by stopping the vehicle that is used in the attack. In the aspect presented on this card, the use of bollards is aimed at increasing standoff distance to an explosion by limiting the access to certain areas to VBIEDs.

Hesco elements are comprised of robust bag-like cuboids that can be filled with gravel or sand. By stacking filled Hesco elements on top and next to each other, a protecting perimeter can be obtained. For the mitigative functionality, the Hesco barriers act to absorb and deflect pressure and impulse effects, as well as stopping fragmentation from an IED. Hesco barriers are widely used in e.g. military camps to provide protection terrorist/insurgent attacks. For camps, the Hesco barriers have been proved as a permanent solution, but they could potentially act as a measure used in situations of a raised threat level for protecting civil infrastructure or establishments.

Market aspects:

With the different type of bollards, ranging from simple concrete blocks to advanced hydraulic wedges, the cost varies in a similar manner. Bollards can be installed in matter of days. Retractable/extendable bollards can be deployed in matter of seconds.

Hesco barrier: COTS:

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
Bollard	2	L-M	P
Hesco barrier	2	L-M	P

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:

Hesco Bastion Limited (UK)

Advance Access; TiSO; Unafor; Perimeter Protection Group;

Research Institutes/Universities active in the field:

JRC Safety and Security of Buildings Unit; University of Warwick UK;

	Status 22.01.2023	Version 1.1

Products types:

Metro vehicles with improved blast resistance and fire safety

Common Characteristics - Overview:

Improve the design of metro vehicles to reduce deaths and injuries, increase resilience, reduce economic impact and make faster recovery in case of an attack.

Application aspects:

Design solutions for increased safety and security of metro vehicles from terrorist attacks by explosives and fire bombs through materials choices and design, thereby increasing resilience and reducing the impact of attacks on passengers, staff, infrastructure and property. Focus on developing materials selection and design strategies for building metro vehicles with intrinsic security features. The threats considered were conventional explosives and fire bombs. Improved resistance of the windows. Clean separation from the body, no shattering thanks to protective film and bonding Improved resistance of the ceiling panels and light/speaker heavy elements by using retaining cables to the vehicle (primary) structure - the ceiling does not fall on the passengers, and does not cover the ground which would make regressing difficult and hazardous Improved lights using LEDs, that maintains its functionality during and after an attack. This is an important point to improve the possibility to enter and egress the carriage, walk safely, assess the damages and bring rescue. Reinforcement of the driver's bulkhead. Use flexible backing layer on certain elements of the secondary structure to improve flexibility under blast loading.

Market aspects:

TRL 5

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
Metro vehicles with improved blast resistance	1	H-VH	M

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:

Research Institutes/Universities active in the field:

The University of Newcastle Upon Tyne; Bombardier Transport France; Fundacion De Los Ferrocarriles Espanoles; Metro De Madrid; Istituto Affari Internazionali; Fundacion Tecnalia Research & Innovation; Explosivos Alaveses Sa; Regie Autonome Des Transports Parisiens; Institut Francais Des Sciences Et Technologies Des Transports, De L'amenagement Et Des Reseaux; Stamtech Srl

	Status 20.01.2023 Version 1.1

Products types:

PROTEXSIS - Enclosure for buildings, Retrofitting with elastomeric polymers, Meandering wall, Sandwich panels

Common Characteristics - Overview:

The goal of walls in the context protection is to mitigate and absorb the shock wave produced by an explosion and to increase a walls resistance to blast effects, and to prevent secondary fragments effects (spalling). Another option for limiting the blast effects is to employ a meandering wall by absorbing energy through plastic deformation of a sandwich core.

Application aspects:

PROTEXSIS consists of panels made of a composite material on the walls of the building to protect both people who are in a building and the structure of the building. One option for retrofitting is the use of an elastomeric polymer coating, which is applied to the surface of the structure and provides some protection against blasting due to its elastic and ductile properties. The coating can be applied by spraying, which reduces application times and costs. The meandering wall is located in the target space, adjacent to a doorway where blast shielding is desired. The wall is wide enough to cover the doorway while allowing people to pass along the sides of the wall as they enter the target space. Both the people and the blast pressure effect are forced to follow a meandering pattern to reach the target room. By attaching sandwich panels to walls or other structures where explosion protection is desired, any blast effects can be reduced before they reach the structure. The driving mechanism in reducing blast effects is the plastic (permanent) deformation of the sandwich core.

Market aspects:

TRL3. Experimental proof of concept.
For retrofitting walls there are several off-the-shelf coatings available. Sandwich cores of different types are widely available, but no dedicated product has been identified at this time.

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
PROTEXSIS	1	M-VH	M
Retrofitting with elastomeric polymers	2	M-VH	M
Meandering wall	2	M-VH	M
Sandwich panels	2	M-VH	M

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:

Durasteel; InterDam B.V; RedGuard; DuraSystems; aalbers|wico; Block Moulds B.V.; RSG Structure LTD; Structural Group Inc., USA; Kawneer; Vetrotech Saint-Gobain; Wrightstyle Systems Ltd.; FORTRESS Protective Buildings;

Research Institutes/Universities active in the field:

Imperial College London, UK; Precast/Prestressed Concrete Institute, USA;

	Status 26.01.2023 Version 1.1

Products types:

Blast Mitigation Windows

Common Characteristics - Overview:

Blast Mitigation Windows are reinforced windows can mitigate the damage caused by a bomb blast and the resulting blast wave.

Application aspects:

There are special windows that are built to withstand explosions from the outset, and there are solutions to retrofit existing windows that reinforce strength with a coating.

Market aspects:

Broad variety of manufacturer with different concept of the windows. Different standards are existing.

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
Blast Mitigation Windows	2	M-VH	M

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:

Impact Security, LLC; Architectural Armour Ltd; Kawneer; AMBICO; InterDam B.V.; Sälzer building security; WINDOW GARD B.V.; Pensher Skytech

Research Institutes/Universities active in the field:

University of Žilina, Faculty of Security Engineering, Univerzitná, Slovakia; University of Trieste, Department of Egineering and Architecture, Italy; ERNCIP Thematic Group Resistance of structures to explosion effects; RISK Research Center, University of the Bundeswehr Munich; University of Missouri, USA; Fraunhofer Ernst-Mach-Institut (EMI); Bundeswehr Technical Centre for Protective and Special Technologies (WTD 52);

Path: Surveillance -> Video (CCTV)	
	Status 23.01.2023 Version 1.1

Products types:
SUBCOP surveillance tool

Common Characteristics - Overview:
Purpose: To locate pedestrians

Application aspects:
The SUBCOP surveillance tool aimed to provide situational awareness in real-time to the operator by providing vision-based guidance. A novel vision based pedestrian detection technology was devised to automatically locate pedestrians within the region of interest. The pedestrian detection algorithm was not dependent on motion; hence it is possible to detect also stationary people. The used algorithms are independent of the scale so that pedestrians can be extracted automatically even when the field of view is changed. The user interface displayed multiple video streams of the same area taken from different viewpoints (cameras). Given the locations of pedestrians in the region of surveillance, the operator can take actions: e.g. choose a safe evacuation direction or initiate a counter action. Intended user or beneficiary are Police/LEA; Security providers. The tool requires installation of surveillance cameras at appropriate position and with sufficient resolution. Requires legal permit to apply video surveillance. Requires operator for target selection in current configuration

Market aspects:
TRL 4 for the concerned algorithms/application and command center of the SUBCOP. Countless other projects and manufacturer are active in the field of video surveillance. Depending on the application there are different solutions for each case.

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
SUBCOP	1	VH	P
CCTV (general)	2	H-VH	P

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:
There is a wide range of manufacturers for every application niche.

Research Institutes/Universities active in the field:

Swedish Defence Research Agency FOI; Netherlands Organisation for Applied Scientific Research, TNO; Fraunhofer-Gesellschaft; CBRNE Ltd; CERBERUS BLACK LTD; (In WP3, many projects have been identified that address the subject of video surveillance. As there are many factors that play a role in each application, it is advisable to go through the Excel list created in WP3 to get specific information.)

Path: Detection & Analytics of Explosives -> Trace (not visible amount) -> **Biosensor**

Products types:

Explosive Detection Dogs (EDD), Bees, Rats

Common Characteristics - Overview:

EDD are globally used in the field of SoE.

Bees and rats can be trained to perform a specific behavior when smelling explosives. The work with bees and rats is mainly scientifically for SoE due the difficulty of implementation the animals in this area. Rats are mainly used in detecting in military scenarios to detect hidden mines.

Application aspects:

EDD´s are very mobile and fast to deploy in a spontaneously occurring crisis situation. EDD´s can track the odour trail of an explosive. Systematic search of open areas, buildings, vehicles, cargo, luggage and persons are possible. EDD´s are used in the REST (Remote Explosive Scent Tracing) procedure to systematically check cargo and baggage for explosives in aviation. In this process, vapour from each source is collected on a filter which is analysed by the EDD. EDD´s can operate for about 15-20 minutes before needing a break to reset. EDD and EDD handler need an appropriate education and regular training. In many cases EDD´s are also used as guard dogs or as part of the task force.

Market aspects:

EDD´s are used by police, military and private companies. In this multi-layered filed of end-user there is a large variety of different approaches for EDD´s. There are many national standards, but no across-the-board standards or certifications

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
EDD	2	M	D
Bees	1	L, M	D
Rats	1	L, M	D

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:

National police and military forces

Private security companies

Research Institutes/Universities active in the field:

Canine Performance Sciences Program, College of Veterinary Medicine, Auburn University, Auburn, AL, United States; The Explosive Detection Dogs Study Group (EDD) ECAC; Netherlands Organisation for Applied Scientific Research, TNO; Fraunhofer Institute for Chemical Technology ICT;

Products types:

High-performance liquid chromatography (HPLC), GC with different detectors (DAD, MS, RI or FID, TCD, MSD, Capillary electrophoresis)

Common Characteristics - Overview:

The goal of chromatographic methods is to identify unknown compounds in complex sample matrices and to quantify low level explosives, contaminants with accuracy and reliability. The basis of any chromatographic measurement is the difference in the interaction of molecules with a stationary phase. In HPLC a pressurized liquid mixture is pumped through column filled with a solid adsorbent material. In GC a gas mixture is pumped through a column filled with a solid adsorbent material.

Application aspects:

Depending on the sample and the information needed from the analysis, different methods and setups have to be chosen. Instrument setups are nowadays designed for a specific application to maximise performance for that application. For example, certain detectors are designed to be very sensitive to certain groups of molecules, while they are not suitable for other groups of substances.

Market aspects:

Chromatographic methods are standard methods in analytical chemistry. There are numerous manufacturers and systems. Since they are standard methods, they are used by many research institutions.

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
HPLC	2	M-H	D, R
GC	2	M-H	D, R

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:

Agilent, Waters, ThermoFischer Scientific, Shimadzu,

Research Institutes/Universities active in the field:

University of Liège, Belgium; Istanbul University Institute of Forensic Sciences, 34303, Cerrahpasa/Istanbul, Turkey; Netherlands Organisation for Applied Scientific Research, TNO; Fraunhofer Institute for Chemical Technology, ICT; Savannah River National Laboratory, Analytical Development, United States; National & Kapodistrian University of Athens, Department of Chemistry, Laboratory of Analytical Chemistry, Greece; Department of Chemistry, Energetic Materials Research, Ludwig-Maximilian University of Munich, Germany; Analytical Chemistry Department, Israel Institute for Biological Research (IIBR), 74100 Ness Ziona, Israel; …

Path: Detection & Analytics of Explosives ->Bulk (visible amount)-> **Electromagnetic Imaging**
Status 25.01.2023   Version 1.2

Products types:

Microwave, Terahertz, IR, Raman, Radar,

Common Characteristics - Overview:

Terahertz radiation is readily transmitted through most non-metallic and non-polar mediums, thus enabling THz systems to "see through" concealing barrier. Many materials of interest for security applications including explosives, chemical and biological agents have characteristic THz spectra that can be used to fingerprint. Terahertz radiation poses either no or minimal health risk. There is a diffuse boundary between terahertz and **microwaves**. Both technologies operate in the range between 100 and 300 GHz. In the infrared (**IR**) spectral range (wavelengths between 1 and 10 microns), clothing, explosive packages, and most other items are opaque to radiation. Thermal radiation can be detected easily with simple, relatively inexpensive IR imaging cameras. **Raman** spectroscopy is an analytical technique based on the scattering of light. The result of this analysis is the production of a Raman spectrum, which plots the intensity of the shifted light versus the frequency. **Radar** systems operate in the 25 - 1000 MHz range and are non-imaging technology. The system transmits low power micro-wave radio waves, which reflect off the object and return to the receiver, giving information about the object. Active radar systems are designed to operate at a stand-off distance.

Application aspects:

Infrared imaging is of considerable interest for scenarios involving suicide bombers since the clothing covering the explosive pack should be at a slightly different temperature than clothing nearer the skin. Radar systems are often used as ground penetrating as military protection system for the detection of Improvised Explosive Devices (IEDs), mines and roadside bombs.

Market aspects:

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
Microwave	2	H-VH	D
Terahertz	1-2	H-VH	D
IR	2	H-VH	D
Raman	2	H-VH	D
Radar	1-2	H-VH	D

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:

Smiths Detection; Rapiscan Systems; Rohde& Schwarz; L3 Communications Security & Detection Systems;

Research Institutes/Universities active in the field:

Fraunhofer Institute for Chemical Technology, ICT; The French Aerospace Lab, Electromagnetism and Radar Department (DEMR), Toulouse, France; Imperial College London, Department of Materials, London, United Kingdom; School of Electrical, Electronic and Computer Engineering, Newcastle University, Newcastle upon Tyne, UK;

Products types:

NQR, NMR, ESR

Common Characteristics - Overview:

NMR: Spectroscopic method for observing local magnetic fields around atomic nuclei. It has excellent characterisation of individual compounds due to very characteristic magnetic fields around atoms. It is a standard method for identification of monomolecular organic compounds.

Nuclear quadrupole resonance (NQR):

NQR transitions of nuclei can be detected in the absence of a magnetic field, which is why NQR spectroscopy is called "zero field NMR". The NQR is only applicable to solids and not to liquids, since in liquids the quadrupole moment is averaged.

electron spin resonance (ESR) or Electron paramagnetic resonance (EPR):

Method for the analysis of materials with unpaired electrons. The basic concepts of EPR are similar to those of nuclear magnetic resonance (NMR), but it is electron spins that are stimulated instead of atomic nuclei spins. EPR spectroscopy is of particular use for the study of metal complexes or organic radicals.

Application aspects:

NQR detectors can detect the presence of bulk quantities of Nitrogen containing explosives and precursors. Semi mobile or fixed (large objects) set-up.

Market aspects:

NQR systems have been commercially available for a number of years, and deployed, however not widely. Examples: cargo screening, shoe screening.

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
NMR	2	H-VH	D, R
NQR	2	H-VH	D, R
ESR	2	H-VH	D, R

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:

Thermofisher; JEOL Ltd.; Oxford Instruments plc; COSA Xentaur; Angstrom Advanced;

Research Institutes/Universities active in the field:

Dept. of Information Technology, Uppsala University, Sweden; Naval Research Lab. (United States); Graduate School of Engineering Science, Osaka University, Japan; Department of Radio Engineering and Information Security, Yuriy Fedkovych Chernivtsi National University, Ukraine; Department of Electronics and Information Technology, Lublin University of Technology, Poland; Méthodologie RMN (UMR CNRS-UHP 7565), Nancy-Université, Université Henri-Poincaré, France

Products types:

Ion Mobility Spectrometry (IMS), Mass Spectrometry (MS), Gas Chromatography (GC), electrochemical, thermal and electrical conductivity, semiconductor, electronic nose, thermo redox

Common Characteristics - Overview:

- Trace quantity detectors (not visible amounts)
- Surface contamination detectors – after swabbing from surface and thermodesorption
- Vapor detectors
- analysis time mostly short (~10 s)
- Result as alarm/no alarm, IMS and MS also with identification capabilities

Application aspects:

Electronic & Chemical detection products are used in a number of application areas.
- Handheld and portable devices
- Benchtop devices used in checkpoints

Sensitivity: μg - ng-range

Technologies are used for applications to prevent attacks, and also in forensic investigations both in the field and at checkpoints (for example airports).

The main users will be staff at checkpoints and military/police.

Market aspects:

Lab Benchtop Analytical Devices and Handheld electronic detectors based on IMS, MS and GC (with all combinations) are relatively mature technologies. IMS as benchtop systems are frequently used at airports. The use of electrochemical, catalytic, thermal and electrical conductivity and electronic noses is often reported in scientific research.

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
IMS	2	M - H	D, R
MS	2	H	D, R
GC	2	H	D, R
electrochemical	1	H	D
Catalytic	1	H	D
thermal and electrical conductivity	1	H	D
electronic nose	1	H	D
thermo redox	1-2	H	D

Stage of Development:	Cost Estimation:		Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)		P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)		D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)		M - Mitigate
	VH - (> 300,000 €)		R - React

Major manufacturers:

IMS (Bruker, L3, MasaTech, Nuctech, Rapiscan, Smiths); MS (FLIR, 1stDetect, 908Devices) GC (Thermo) Thermo-redox (Scientrex),

Research Institutes/Universities active in the field:

IMS: University of Geneve (CH), University of Duisburg-Essen (D)

Electronic nose: FhG-UMSICHT (D); Electrochemical: FhG-ICT (D)

Products types:

Time-of-flight mass analyzer, Quadrupole mass analyzer, Ion trap mass analyzer, Tandem mass spectrometer (MS/MS)

Common Characteristics - Overview:

Separation and analysis of substances according to the masses of atoms and molecules of which the substance is composed. There are methods based on time separation and the methods based on geometric separation. Mass spectroscopy offers great potential for vapour and trace detection of explosives due its high sensitivity (ppt-ppq)., selectivity and speed of analysis.

Application aspects:

Various ionization modes have been developed and coupled to meet specific application criteria in the field of SoE:

- atmospheric pressure chemical ionization (ACPI) and corona discharge ionization for detection of TNT with detection limit of 0,3 ppt.
- Direct analysis in real time (DART): several ionization mechanisms possible -> system equipped with DART can directly detect compounds on surfaces without requiring sample preparation.
- Desorption electrospray ionization (DESI) uses an aqueous spray directed at an analyte deposited on an insulating surface. Addition of reagents in the spray solution formed characteristic adduct ions that improved selectivity and identification capability compared to ESI.

Market aspects:

Mass spectrometry is one of the most common methods in analytic laboratory's and is therefore well established. Due to new developed parts and the general need for better analytics sensitivity, selectivity and speed of analysis are still improving. Mass spectroscopes are also commonly used in particle detection systems. Manufacturers develop mobile and miniature mass spectrometers to provide a laboratory in the field.

Spectrometry technology are often adapted for detection applications like personnel screening portals, trace explosive residues on boarding passes, etc.

Technology: Spectroscopy	Stage of Development	Cost Estimation	Counter Attack Phase
ToF	2	H, VH	R
QMS	2	H, VH	R
IMS	2	H	R
MS/MS	2	H, VH	R
Mobile, compact MS	1,2	H	D

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:

Agilent, Bergmann Messgeraete Entwicklung (BME), Bruker, Hitachi Instruments, Oerlikon, PerkinElmer, Pfeiffer Vacuum GmbH, Shimadzu Scientific Instruments, Inc., Thermo Scientific

Research Institutes/Universities active in the field:

Institute for Atmospheric and Earth System Research/Physics, University of Helsinki, FI-00014, Helsinki, Finland; National Measurement Laboratory, LGC, Teddington, UK; University of Rhode Island, Kingston, RI, United States;

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Products types:

Fast neutron analysis (FNA), Pulsed FNA (PFNA), Thermal neutron analysis (TNA), PFTNA

Common Characteristics - Overview:

The major advantage of neutron interrogation systems is that it is hard to shield the target material from fast neutrons, which can pass through iron and lead shields with very little attenuation. X-rays and gamma rays, on the other hand, can be shielded by middle to high atomic number dense materials. Neutrons are also effective in differentiating between various types of organic materials. Neutrons are not affected by electromagnetic forces, they interact only with nuclei with high specificity and can be tagged in both time and space

PFTNA technique provides a bulk analysis of the chemical present and uses 10μs pulsing as compared to **PFNA** which uses 2 ns pulsing. It also has the main advantage of being portable and allows the neutrons to be moderated for the measurement of thermal neutron gamma-rays. PFTNA can provide thermal neutron information like TNA but, in addition, it also measures fast neutron interactions. PFTNA can provide thermal neutron information like TNA but, in addition, it also measures fast neutron interactions.

Application aspects:

The neutron source (either a radioactive source such as Californium (252Cf) or Americium-Beryllium (AmBe) or an accelerator source of the D-D (deuterium-deuterium), or D-T (deuterium-tritium) type) may bring along some practical problems of storage, transport, registration. Neutron sources emit neutrons in all directions, which means that careful shielding is needed when they are in operation, so that only the target is irradiated - both for safety and health considerations, and to limit background noise.

Market aspects:

Usage of neutrons technology as a second unit of a luggage checking systems combined with x-ray to reduce the drawbacks of a single technique.

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
FNA	2	H-VH	D
PFNA	2	H-VH	D
TNA	2	H-VH	D
PFTNA	2	H-VH	D

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:

Thermofisher; Malvern Panalytical; sodern;

Research Institutes/Universities active in the field:

Defence R&D Canada—Suffield, Medicine Hat, Alta., Canada; Laboratories for Detection of Landmines and Illicit Materials, Nuclear Research Centre, Atomic Energy Authority, Cairo, Egypt; Purdue University, Indiana, USA;

Products types:

Spectroscopy: IR, Raman, spatially offset Raman (SORS), LIBS/Plasma, PF-LIF, Flame Photometry, UV-VIS, Fluorescence, chemiluminescence

Common Characteristics - Overview:

- Direct materials specific detection (in-situ)
- Surface contamination detectors
- Visible quantity detectors
- Vapour detectors

No detection of explosives concealed in inanimate objects (except for SORS--> chemical analysis of objects beneath thin obscuring surfaces, such as tissue, coatings and bottles are possible)

Application aspects:

Optical & Spectroscopy detection products are used in a number of application areas.
- Handheld devices (IR/Raman)
- Lab Analytics
- Standoff Devices

Sensitivity: mg-range, (focusing lab devices up to sub µg-range)

Technologies are used for applications to prevent attacks, and also in forensic investigations both in the field and in the laboratory.
The principal users will be laboratory staff and military/policemen in the field.

Market aspects:

Lab Benchtop Analytical Devices and Handheld IR/Raman detectors for contactless but low-distance detection are relatively mature technologies.
Standoff-Devices are until now not COTS-available. (only research prototypes)

Technology: Spectroscopy	Stage of Development	Cost Estimation	Counter Attack Phase
IR	2	H	D, R
Raman	2	H	D, R
Spatially offset Raman (SORS)	2	H	D
LIBS/Plasma	1-2	H	D
PF-LIF	2	H	D
Flame Photometry	2-3	M	R
UV-VIS	2	M	R

Products vary in cost from 15.000 € (M) to 250.000 € (H) and above (VH).

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (> 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:

Thermo (Nicolet), Agilent, Bruker, Shimadzu, Horiba, Metrohm

Research Institutes/Universities active in the field:

Fraunhofer IAF, FOI, ENEA, DLR

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Products types:

UV/ Vis, NMR, IR, Raman, ICP, EA, XFR

Common Characteristics - Overview:

Spectroscopy-based techniques play an irreplaceable role in the detection of energetic substances because they are fast, automatic and non-contact.

Application aspects:

Depending on the task, the analysis of a sample can present a different challenge. Some analyses can be carried out with standard methods using simple samples, other analyses require complex method development and sample preparation as well as defined sampling.

Market aspects:

Spectroscopic methods are standard equipment in analytical laboratory chemistry. Depending on the application, different levels of equipment, methods, etc. are needed.

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
UV/ Vis	2	H-VH	D, R
NMR	2	H-VH	D, R
IR	2	H-VH	D, R
Raman	2	H-VH	D, R
ICP	2	H-VH	D, R
EA	2	H-VH	D, R
XFR	2	H-VH	D, R

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:

Mettler Toledo, Eppendorf, Hitachi, Shimadzu, PerkinElmer, Analytik Jena, Agilent

Research Institutes/Universities active in the field:

Department of Materials Science and Engineering, University of Florida, USA; Department of Physics, Chemistry and Biology (IFM), University of Linköping, Sweden; Department of Pure and Applied Chemistry, Technology and Innovation Centre, University of Strathclyde, Glasgow G1 1RD, United Kingdom; Department of Physics, Gebze Technical University, Turkey; Université Pierre et Marie Curie, Ecole de Physique et Chimie Industrielles, Paris, France;

Products types:

Ion Mass Spectrometry (IMS), Fluorescence Spectroscopy, Chemiluminescence, Capillary Zone electrophoresis, High pressure Mass Spectrometry, Colometric analysis

Common Characteristics - Overview:

- Detection of explosives from surfaces
- Sample may not be visible for human eye
- Swab is used to collect a particle sample
- Short analysis time possible (few seconds)
- Chemical test kits provide analysis of unknown substances in the field
- Colometric analysis provides method of determining the concentration of chemical compound in a solution with the aid of a color reagent.

Application aspects:

- Portable, semi-portable and Benchtop devices are available.
- Sensitivity: ng to µg-range

Swab detection systems:

- Used at airports to spot-check carry-on baggage and passengers for traces of explosives.
- Other application scenarios possible: Customs, entrance control at concerts, sport events, etc., check of postal traffic.

Chemical test kits:

- Mainly used by military, policeman and first responder for forensic investigations.
- Multiple purpose Chemical test kits and devices are on the market that cover toxic materials, radioactive materials, drugs and explosives.

Market aspects:

Trace Detection Devices are globally used in aviation and therefore a very matured technology for this application. Systems for the market in the EU are certified on commission by the ECAC which guarantees a similar performance level. For other applications outside the aviation market there are no certifications in place which leads to the problematic that systems are difficult to evaluate for end-user.

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
IMS	2	M-H	D, R
Fluorescence Spectroscopy	1-2	M	D, R
Chemiluminescence	1-2	M	D, R
Capillary Zone electrophoresis	1-2	M-H	D, R
High pressure Mass Spectrometry	1-2	M-H	D, R
Colometric analysis	1-2	M	D, R

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:

Bruker, smiths detection, MX908, GreyScan, RS DYNAMICS; Tri-Tech Forensics, Inc.;

Research Institutes/Universities active in the field:

Fraunhofer ICT, TNO Netherlands; ETD Study Group ECAC; DHS USA;

Path: Detection & Analytics of Explosives -> Trace -> Vapour Detection

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Products types:

Direct Vapour Sampling, High Volume Sampler (HVS)

Common Characteristics - Overview:

Direct vapour sampling detection systems are mostly handheld devices that analyse a small amount of the respective atmosphere. The results are available immediately. Current direct vapour sampling detection systems are designed for substances with a relatively high vapour pressure.

High-volume sampler systems analyse a larger volume, e.g. a container. The collected atmosphere is concentrated onto a pre-concentrator. Coupled with more sophisticated (and larger) detector elements, improved detection becomes possible compared to direct vapour detection. Detection of less volatile substances and detection of lower concentrations is thus possible.

Application aspects:

Direct vapour systems are used as supplementary tool when immediate results are needed. High volume sampling systems are stationary or semi mobile and need more time for analysis.

Market aspects:

The handheld devices are often multi-purpose devices that offer the possibility of detecting particles via a swab. In addition, the libraries often contain drugs and other hazardous substances.

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
QEPAS (BONAS)	1	H	D
SERS sensor (BONAS)	1	H	D
Vapour phase Raman detector (EMPHASIS)	1	H	D
Eye safe QCL-IR precursor vapour detection (EMPHASIS)	1	H	D
Vehicle mounted precursor vapour detector (LOTUS)	1	H	D
Inline QCL detector for precursor vapors (XP-DITE)	1	H	D
SNIFFER Detector	1	H	D
Griffin 460 GC/MS	2	H	D
HVS	1-2	VH	D

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:

Karsa Ltd; Mion Technologies S.L.; Flir; Nuctech, CEA; Bruker; smiths detection; Rapiscan; MS Detection; Teknoscan; RS Dynamics; MSE;

Research Institutes/Universities active in the field:

IMEM-CNR Institute, Parma, Italy; EVD Study group ECAC; Netherlands Organisation for Applied Scientific Research, TNO; Fraunhofer Institute for Chemical Technology ICT;

Products types:

Single/dual/high energy, transmission, Multi-view/computed tomography (CT), backscatter, X-ray Diffraction, x-ray computed tomography, dielectric measurements

Common Characteristics - Overview:

A gamma ray and x-ray are a penetrating form of high-energy electromagnetic radiation. One common practice is to distinguish between the two types of radiation based on their source: X-rays are emitted by electrons, while gamma rays are emitted by the atomic nucleus.

Application aspects:

- Single x-ray imaging: single shot or continuous x-ray exposure, + high speed (1500 luggage/hour), - covering of objects due to overlap and similar x-ray shadows of certain household items and explosives
- Dual energy x-ray systems: reducing shadow similarities and overlapping when x-ray sources are rotated at an angle of 90°.
- CT systems: x-ray source and detector rotate around the luggage. By collecting multiple images per item reconstruction software enables to display 3D images.
- x-ray backscatter imaging for better material identification

Market aspects:

Widely used at airports or critical infrastructure to check luggage. Other applications are aiming to check larger objects like trucks. Improvement of algorithms with machine learning expected.

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
Single X-ray imaging	3	VH	D
Dual energy x-ray systems	2	VH	D
CT systems	2	VH	D
x-ray backscatter imaging	2	VH	D

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:

Nuctech, Bruker, smiths detection, leidos; Rapiscan systems;

Research Institutes/Universities active in the field:

Fraunhofer Institute for Integrated Circuits IIS (EZRT), Fraunhofer Institute for Chemical Technology ICT, School of Engineering, Cranfield University Bedfordshire U.K.; Department of Radiation Convergence Engineering, Yonsei University, Republic of Korea; Durham University, UK;

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Products types:

Face recognition, Iris recognition, Automated fingerprint identification/ verification, DNA analysis

Common Characteristics - Overview:

The aim of face recognition is to identify a person, e.g. a truck driver in the project ARENA. This is done by the use of sensors and software algorithms. Police forces in at least 21 countries of the European Union use, or plan to use, facial recognition systems, either for administrative or criminal purposes. Face recognition systems are used worldwide. Iris recognition is an automated method that applies mathematical pattern recognition techniques to video images of one or both irises of a person's eyes, whose complex patterns are unique and stable and can be seen from some distance. Iris recognition allows false hits to be avoided even when cross-referencing across large populations. Automated fingerprint identification uses a computer to match fingerprints against a database of known and unknown prints. Automated fingerprint verification is a closely related technique that verifies a claimed identity, whereas identification systems determine identity solely from fingerprints. With secured blood/saliva/etc. samples from suspected bodies (parts) at a crime scene, a laboratory analysis and database comparison can lead to the fast identification (<6h) of a person involved in the crime.

Application aspects:

The biggest limitation with iris recognition is that capturing images from distances of more than a meter or two, or without cooperation, can be very difficult. Many countries, including the European Union, have their own automated fingerprint identification systems that are used for a variety of purposes, including identifying criminals, checking the background of applicants, receiving benefits and receiving credentials (such as passports). For DNA analysis, the main disadvantage is that a relatively large (e.g. blood drop) biological sample must be available.

Market aspects:

Many countries, including the European Union, have their own automated fingerprint identification systems that are used for a variety of purposes, including identifying criminals, checking the background of applicants, receiving benefits and receiving credentials (such as passports).
DNA Analysis: Operational

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
Face recognition	1-2	M-VH	P
Iris recognition	2	M-VH	P
Automated fingerprint identification/ verification	2	H-VH	P
DNA analysis	2	L	R

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:
IDEMIA; TECH5; CMITech; Thales Group; BioEnable; IrisGuard; HID Global; Iris ID; FotoNation;

Research Institutes/Universities active in the field:
Department of Computer Sciences, University of Salzburg, Salzburg, Austria; Universiti Tunku Abdul Rahman, Malaysia; Queensland University of Technology, Australia; Computer Science Department, Faculty of Computers and Information Technology, Future University in Egypt, New Cairo, Egypt

| | Status 27.01.2023 Version 1.2 |

Products types:

Hand held metal detector, Walk-through metal detection

Common Characteristics - Overview:

Metal detector consists of an oscillator producing an alternating current that passes through a coil producing an alternating magnetic field. If a piece of electrically conductive metal is close to the coil, eddy currents will be induced in the metal, and this produces a magnetic field of its own. If another coil is used to measure the magnetic field (acting as a magnetometer), the change in the magnetic field due to the metallic object can be detected.

Apart from WTMD (Walk-through metal detection) and HHMD (Hand held metal detector), metal detectors have also been designed for specialist purposes, such as the screening of shoes, or ground search for buried IEDs.

Application aspects:

Handheld metal detectors scan an individual, while keeping hand away from their body. (The alarm signaling modes include: optical alarm proportional to the intensity of the detection signal; acoustic alarm with a tone which is proportional to the size of the object detected; vibration alarm signal). Operating Frequency 9,5 or 12kHz Multi-purpose multi-zone walk-through metal detectors are used primarily for weapons detection.

Market aspects:

Global usage at:

mass transit hubs (airports, train and subway stations, seaports) government buildings (courthouses, prisons, police stations, embassies, customs), public buildings (schools, hospitals, stadiums, casinos and discotheques), private and corporate buildings (banks, factories, offices), critical infrastructure ((nuclear) power plants).

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
HHMD	2-3	L	
WTMD	2-3	L, M	

Stage of Development:	Cost Estimation:		Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)		P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)		D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)		M - Mitigate
	VH - (> 300,000 €)		R - React

Major manufacturers:

The commercial market is very large. There are a high number of suppliers for each application.
For example, 2 list with 130 and 138 entries:
https://www.environmental-expert.com/companies/location-europe/?keyword=metal-detectors
https://www.europages.co.uk/companies/metal%20detectors.html

Research Institutes/Universities active in the field:

Radio-Frequency Technology Divison, National institute of Standards and Technology, USA; Czech Technical University in Prague, Faculty of Electrical Engineering, Czech Republic; Department of Engineering Physics, Yangon Technological University, Yangon, Myanmar;

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Products types:

MMW portals

Common Characteristics - Overview:

MMW portals operate in the 30 - 300 GHz range and are available in two forms:

- Active systems use low power millimeter-wave radio source(s) to illuminate the scene with electromagnetic radiation waves, which penetrate through clothing and reflect off the human body. The return signal travels back to the transmitter which also acts as a receiver. As the waves do not penetrate the skin, MMW scanners cannot detect potential threats inside the human body.
- Passive systems detect a combination of radiation naturally emitted from the body and radiation reflected from the environment (ambient radiation). Anomaly detection is based on the effective temperature difference between the objects and the human body.

Application aspects:

People may be requested to (partially) divest to avoid unnecessary false positives, i.e. detection of benign objects. Depending on the ConOps of the equipment, a person may be requested to take a certain posture (e.g. have the arms raised and bent at the elbows during the scanning process).

Border control; Security personnel

Market aspects:

Certified active MMW systems are used on airport checkpoints all over the world.
Low to medium TRL for passive systems and medium to high TRL for active systems.

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
Active MMW	2	H-VH	D
Passive MMW	1-2	H-VH	D

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:

Smiths detection; Nuctech, leidos; EAS Envimet Analytical Systems Ges.m.b.H.; Rohde& Schwarz;
L3 Communications Security & Detection Systems;

Research Institutes/Universities active in the field:

School of Electrical and Electronic Engineering, University of Manchester, United Kingdom; Fraunhofer Institute for High Frequency Physics and Radar Techniques FHR; Department of Medical Laboratory and Radiation Sciences, University of Vermont, Burlington, USA; Pacific Northwest National Laboratory, Operated for the U. S. Department of Energy by Battelle Memorial Institute, Richland, WA, USA;

Path: Other Detection -> Seismometers	
	Status 13.01.2023 Version 1.1

Products types:

Geophones (50-750V/m), Local geologic seismographs (1500 V/m), Teleseismographs (20 000 V/m)

Common Characteristics - Overview:

A seismometer responds to ground movements such as those caused by earthquakes, volcanic eruptions and explosions. If this instrument is also combined with a timing and recording device, a seismograph is obtained.

Application aspects:

Explosions and earthquakes both release a large amount of energy very quickly, and both can be recorded by seismic instruments. However, because the forces involved in each are very different, the waveforms that each creates look different. Nuclear explosions typically release energy between 2-50 kilotons of yield, compared to, for example, the M6.5 Afghanistan earthquake in May of 1998 that had an equivalent yield of 2,000 kilotons.

Microearthquake seismic monitoring systems can be used to monitor critical locations such as ATMs, doors, concrete walls, etc. - detecting the vibrations generated by the explosion.

Market aspects:

Teleseismographs are used to survey the world and study the inner structure of the earth.
Geophones are available from different manufacturers for different SoE applications.

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
Geophones	2	L-M	R
Local geologic seismographs	2	M-H	R
Teleseismographs	2	H-VH	R

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:

Contact ESS Earth Sciences; CSI (Cable & Supplies, Inc); GeoVista; Dynamic Technologies (DTCC); Geophysical Instrument Supply Company (GISCO); PASI s.r.l.; M.A.E. Advanced Geophysics Instruments; Geotomographie GmbH; Geomatrix Earth Science Ltd; Solgeo srl; GEOSPECTRUM S.C.;

Research Institutes/Universities active in the field:

GFZ German Research Centre for Geosciences; Centre for Exploration Geophysics, Curtin University, Bentley, WA 6151, Australia; Research Institute of Innovative Technology for the Earth (RITE), Kyoto, Japan;

Path:			
Other Detection -> Screening of other things -> Various tools		Status 20.01.2023	Version 1.1

Products types:

Non Linear Junction Detector (NLJD), Visual inspection, VALCRI (intel information analytics), Portable 3D-reconstruction sensor tool

Common Characteristics - Overview:

The Non Linear Junction Detector (NLJD) detects electronic devices when active, dormant or switched off and gives audible and visual indication of threat. The principle of NLJD equipment operation is based on emission of high radio frequency energy in an area. Detectors have a sensitive receiver designated for reception of objects' echo signals which, for operator's convenience, are marked down with sound or displayed on graphical user's interface.

Visual inspection is a common detection method using human senses such as vision, hearing, touch and smell and/or any non-specialized inspection equipment (e.g. camera, mirror, etc.).

VALCRI is a semi-automated analysis system that helps find connections humans often miss. When pre-empting crime or investigating a case, it can be deployed by analysts to reconstruct situations, generate insights and discover leads.

The purpose of the Portable 3D-reconstruction sensor tool is to 3D reconstruct a post-blast area (or any area of importance).

Application aspects:

The Non Linear Junction Detector is used for detecting hidden electronic devices in buildings, offices, homes, cars and many other environments.

Through autonomous work or collaboration with a human team, VALCRI creatively analyses data from a wide range of mixed-format sources. It displays its findings with easy-to-digest visualizations, comes up with possible explanations of crimes, and paves the way for rigorous arguments.

The 3D reconstruction can be used both indoors and outdoors with sufficient lighting.

Market aspects:

NLJD: Commercial product
VALCRI: TRL 3
3D reconstruction: TRL 5

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
NLJD	2	M	P, D
Visual inspection	2	L	P
VALCRI	1	H	P, R
3D reconstuction	1-2	M	R

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:

NAVIDEO; Research Electronics International, LLC.; Westminster Group Plc; Alarmservice parduotuvė;

Research Institutes/Universities active in the field:

Middlesex University Higher Education Corporation; Space Applications Services Nv; Linköping University, Sweden; Universität Konstanz, Germany; Fraunhofer Institute of Optronics, System Technologies and Image Exploitation IOSB;

	Status 23.01.2023	Version 1.1

Products types:

UAV (unmanned aerial vehicle), UGV (Unmanned Ground Vehicles)

Common Characteristics - Overview:

UAVs and UGVs can be used to complete tasks from a safe distance to protect persons from possible harm (e.g. inspection of suspicious baggage). Several applications like UAVs equipped for surveillance tasks are possible.

On the other hand, there is the need to detect, identify and neutralize UAVs used by a criminal.

Application aspects:

- Detection, classification, and localization the threat, using radar, optronic, acoustic and other sensors.
- Command and control (C2) with storage, data learning, data diffusion, decision support, investigation, intelligence, etc.
- Neutralization (activation and driving) using jamming, hacking, nets, guns, others.

UGVs can be equipped with sensors to remotely monitor the environment (electronics, digital video transmission, camera, x-ray systems)

Market aspects:

Drone Detection, Identification & Neutralization: TRL 7 (ALADDIN)

Technical solutions are available, but there have not been many incidents in Europe, so there is not much experience in dealing with hostile UAVs. Since numerous modus operandi can be considered, it is difficult to prepare specifically for LEAs. Legal frameworks are to some extent not clarified in the defence against UAV.

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
Drone Detection, Identification & Neutralization	1-2	L-H	D, R
UGV bomb inspection	2	H-VH	D, R
UAV surveillance	2	H	D

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:

Infiniti Electro Optics; Blighter Surveillance Systems Limited; Dedrone; URSA, Inc.; Exail; ECA Group; L3Harris Technologies, Inc; NIC Instruments Ltd; QinetiQ; Robotnik Automation S.L.; Telerob Gesellschaft für Fernhantierungstechnik mbH; ASELSAN A.Ş.; Roboteam;

Research Institutes/Universities active in the field:

Center for War Studies; Deutsches Zentrum für Luft- und Raumfahrt German Aerospace Center (DLR); Netherlands Organisation for Applied Scientific Research, TNO; S&T organization; US Army TARDEC Robotic Mobility Lab, Belleville;

	Status 27.01.2023 Version 1.1

Products types:

Inhibition of precursors and explosives

Common Characteristics - Overview:

The goal is to prevent t publicly available precursors being used for HME production.

Application aspects:

Regulation is needed to enforce the inclusion of inhibitors in products, as this is not done voluntarily by companies and distributors. Exempted from this end-use regulation are industrial chemicals.

Market aspects:

The infrastructure for the additive must be established, i.e. where in the distribution chain the additive is added. The products used must be products that are available to the general public.

Legal decisions carry far-reaching consequences for the industry and must be carefully weighed and well justified.

Precursor regulation of the EC

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
Juridical	2	VH	P

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:

European Commission

Research Institutes/Universities active in the field:

Swedish Defence Research Agency FOI; Netherlands Organisation for Applied Scientific Research, TNO; Brodarski Institut d.o.o. Croatia; Fraunhofer-Gesellschaft; Le Commissariat à l'énergie atomique et aux énergies alternatives (CEA), France;

Path: Other Technology -> Security/ Crisis management -> Inhibition -> technical
Status 27.01.2023   Version 1.1

Products types:
TATP, Fertilizer (ammonium nitrate), HMTD, Hydrogen Peroxide, Nitromethane

Common Characteristics - Overview:
TATP, HMTD synthesis inhibition: additive for Acetone to disrupt synthesis of TATP.
Fertilizer chemical inhibition: additive based on dilution to prevent detonation.
Hydrogen Peroxide, Nitromethane enrichment inhibition: additive which prevents concentration of H2O2, MeNO2.

Application aspects:
The infrastructure for the additives needs to be established, i.e. where in the distribution chain the additives are added. Technical inhibition of certain chemicals is effective because it blocks chemical routes that have been abused. The question is whether criminals will find a way to circumvent the inhibition or whether they will take advantage of other chemicals.

Market aspects:
TATP: TRL 3-4
H2O2, HMTD, Fertilizer: TRL 3
MENO2: TRL 7
Main cost is infrastructure implementation and the additional cost of the inhibitor compared to pure product. In contrast to the costs of ordinary security technologies, these costs are borne by the industry, so that the implementation of these measures must be well justified in order to be enforced.

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
TATP	1	VH	P
Fertilizer	1	VH	P
HMTD	1	VH	P
Hydrogen Peroxide	1	VH	P
Nitromethane	2	VH	P

Stage of Development:	Cost Estimation:		Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)		P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)		D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)		M - Mitigate
	VH - (> 300,000 €)		R - React

Major manufacturers:
Research Institutes/Universities active in the field:
Swedish Defence Research Agency FOI; Netherlands Organisation for Applied Scientific Research, TNO; Brodarski Institut d.o.o. Croatia; Fraunhofer-Gesellschaft; Le Commissariat à l'énergie atomique et aux énergies alternatives (CEA), France;

	Status 27.01.2023	Version 1.1

Products types (examples):

Forensic sampling protocol, ReSuMe – Response Support Model, Psychological intervention guide, A-WASP (Acoustic Warning Signal Projector), Risk Assessment Tool, information sharing

Common Characteristics - Overview:

A variety of safety management tools, guides and platforms have been developed to prepare, prevent or to handle different situations in the field of SoE. There are guides for taking explosives samples after explosions, or to provide qualitative direction on what psychological approaches (or tools) might be effective in a given situation. Models have been developed to provide an objective view of the impact and possible negative consequences for suspects, the public and first responders. Tools have been developed to communicate at a distance with a crowd or offender. There are tools to keep officers informed of the latest terrorism-related activities and platforms to provide secure expert advice and training to businesses and public sector organizations. Various risk assessment tools are available to evaluate a potential risk based on, for example, written communication, behavior or psychological aspects.

Application aspects:

Market aspects:

Depending on what type of application you are looking for, there are several research projects and systems that do not fit into the other technologies but are related to the SoE field.
SUBCOP: Cerberus Black Ltd, Cambridge, UK (SUBCOP): Superhailer: An acoustic communications device used at long range for the Police, Emergency Services and Military.
A-WASP: A communication tool with the capability designed to guarantee the attention of individuals or small groups and persuade or instruct them at ranges greater than 250m.
PRAT TRL 2
TRAP-18, VERA: TRL 9

Technology:	Stage of Development	Cost Estimation	Counter Attack Phase
procedures when responding to a suspected bombing	1-2	L-M	R
A-WASP	2	M	R
Superhailer	2	M	R

Stage of Development:	Cost Estimation:	Counter Attack Phase:
1 - emerging	L - low (< 3,000 €)	P - Prevent
2 - mature	M - medium (3,000 - 30,000 €)	D - Detect
3 - obsolescent	H - high (30,000 - 300,000 €)	M - Mitigate
	VH - (> 300,000 €)	R - React

Major manufacturers:
Cerberus Black Ltd;

Research Institutes/Universities active in the field:
Swedish Defence Research Agency FOI; Netherlands Organisation for Applied Scientific Research, TNO; Fraunhofer-Gesellschaft;

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Scenario: Criminal use of explosives

The fourth annual report in EXERTER

EXERTER
Scenario: Criminal use of explosives -
The fourth annual report in EXERTER

FOI-2017-1045
June, 2022

Photo: FOI

Security of Explosives pan-European Specialists Network

EXERTER is a pan-European network that aims at identifying and promoting innovative methods, tools, and technologies that will offer solutions in the fight against terrorism and serious crime, thus enhancing the overall Security of Explosives. The core of the EXERTER network brings together experts from Law Enforcement Agencies (LEAs), military institutes, governmental and civilian research institutes, academia, and standards organisations.

By enabling the exchange of information about the challenges of countering current and emerging threats, the related operational requirements on methodologies, tools and technology, and the status in research and innovation, EXERTER provides practitioners with the operative knowledge and tools for enhancing the security of our society.

Each year, EXERTER focuses on a scenario or set of scenarios with connection to Security of Explosives. The scenario is a plot defined from planning to execution of an attack, and is used to identify weaknesses in our response as well as potential countermeasure improvement. Focus is on the areas standardisation and certification, research and innovation, and exploitation.

The scenario for year four in EXERTER revolves around the criminal use of explosives. A summary of the work, analysis, and recommendations related to this year's scenario is presented in this report.

INTRODUCTION

Each year, EXERTER defines a scenario or set of scenarios, based on relevant input from practitioners and experts, and works with issues related to that scenario in all four phases on the time-line: PREVENT, DETECT, MITIGATE, and REACT. EXERTER studies requirements, gaps, and activities within research, standardisation, and certification, and works towards exploitation of innovations within all phases.

Countermeasures under the four domains differ technically and operationally, and have different sets of users and stakeholders, thus setting a wide scope for the EXERTER network.

This report summarises the outcomes of EXERTER from the work with scenarios involving the criminal use of explosives. It presents the findings related to the different counter attack domains and presents the concluding analyses and recommendations on future possibilities and needs.

In the beginning of EXERTER's yearly cycle, practitioners' requirements and gaps for countering the threat scenario were identified. These were based on analysis of input received from stakeholders and the expert community. The information has been collected in a classified report and it has formed the foundation for the continued work.

Scenarios

The scenarios revolve around the illegal use of explosives. The motives vary. Unlike terrorists, the ultimate aim is to maximise profits and reduce risks, rather than to draw attention to themselves.

Financial gain

Robbers attack an ATM for cash. The denotation leads to partial destruction of the ATM safe, and fragments reaching 200 meters, hitting a passer-by.

A gang extorts local businesses for 'protection money'. They extensively damage one shop owner's car by initiating a small pipe bomb and a banger.

Power gain

A gang member initiates an improvised explosive device (IED) via a black powder fuse at a residence building entrance to eliminate an enemy.

A gang revenges a theft by placing a timed blast incendiary at night on the windowsill of a bedroom window.

To intimidate a witness a low-level home-made explosive (HME) is detonated outside the witness' house.

Personal gain

Misuse of pyrotechnics for fun – A football supporter smuggles flash-bangers into a football stadium and lights them. Some bangers cause injuries to bystanders; burns to the skin, damage of hearing and cuts due to fragments from the bangers.

PREVENT

This chapter offers suggestions to reduce the risk from the criminal use of explosives; it tries to address the issue before anything illegal happens. Since this is an international topic, an approach could benefit from being taken at a European level. Furthermore, we describe how legal users of explosives, for instance, the mining industry, could play an essential role in crime prevention.

REGULATION & LEGISLATION

Past cases where explosives, precursors, and pyrotechnics have been used to cause harm, by accident or on purpose, can illustrate the risk level to legislators, manufacturers and the public. Laws and regulations governing explosives, precursors, and pyrotechnics have been extended and become stricter during recent years. However, there are still actions that can be made to further prevent criminals from using them.

For instance, EU could harmonise procedures for cargo checkpoints to prevent commercial and military explosives from being imported or smuggled from other countries. A unified European approach in legislation

Photo: MONUSCO Photos, CC BY-SA 2.0, https://creativecommons.org/licenses/by-sa/2.0, via Wikimedia Commons

that specifies the type of legal products and limits their size could potentially reduce smuggling of pyrotechnics. A harmonised legislation could also include e.g. grading sentences for possession of pyrotechnics according to the damage potential.

Photo: FOI

Surveillance of open sources (e.g. social media) could be considered to reduce the access to instructions on the internet on how to make explosive charges. The legal framework for securely storing and handling mass data must then be considered, along with privacy issues.

Furthermore, regulations on businesses that legally use explosives (e.g. construction- and mining industry)

Possible suggestions to improve prevention:

- Harmonised European pyrotechnic legislation to sentence according to damage potential and checkpoint procedures to reduce smuggling
- Stricter explosives control in the industry to minimise theft and illegal trade, regular background checks of employees, and improved reporting of missing explosives
- Improved communication within institutions, between LEAs, between the military and civilian sectors, and on an international level
- Increased internet surveillance to spot preparation instructions for explosive charges

could be increased regarding access requirements in order to reduce theft and illegal trade with explosives. Making regular background checks of all employees with access to explosives mandatory, and following procedures for immediately reporting and investigating missing explosives are other efforts to reduce illegal use of explosives.

Research Initiatives & collaboration

There is typically an excellent response rate and communication during and after crisis events, but sometimes a lack of communication in the prevention phase. Hence, communication could improve within institutions, between LEAs, between the military and civilian sectors, and on an international level to hinder/stop attack plots at an early stage.

The identified research initiatives mainly fall into three focus areas: collaboration, video surveillance, and analysis.

Several research projects revolve around improved collaboration between different LEAs and between the police and the public. CAPER, helps prevent organised crime through a platform for sharing, exploitation and analysis; INSPEC2T improves collaboration between police and the community; and UNITY involves the community in identifying policing priorities.

SAFEPOST raised postal security by screening parcels and TAKEDOWN analyses the dimensions of organised crime and terrorist networks

Video surveillance is the common focus of SMARTPREVENT, VALCRI and VICTORIA. SMARTPREVENT exploits the full potential of video surveillance, VALCRI analyses footage for sense-making in criminal intelligence analysis, and VICTORIA analyses videos for criminal and terrorist activities.

Detect
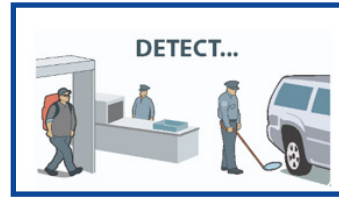
The discovery of a planned, ongoing, or concluded act of crime is one key element in the chain of crime-fighting. To detect the criminal use of explosives, here, we illustrate possible technologies that range from surveillance technology that automatically assists trained human operators to sensors that allow the detection of explosives from a distance.

Research Initiatives

Identified research activities for the detection domain cover e.g. surveillance technologies and algorithms for data analysis.

The EU-funded project CoESS works on training of Explosive Detection Dog (EDD), other projects such as CHEQUERS, MiRTLE, STANDEX and DEXTER have worked on identifying explosives and weapons in different environments. There are also several research initiatives around CCTV and other surveillance systems, such as the EU-funded AWARE project.

Challenges & Possibilities in Detection

The scenarios present a wide variability in the modus operandi on how an attack could be potentially performed, making identifying detect solutions challenging. The detection phase for some of the proposed scenarios might be the weakest link in the C-IED chain for some of the proposed scenarios.

Moreover, detection technology might not be the optimal solution for some scenarios because it would require

Identified reaserch suggestions:

- Innovative crowd behaviour analyses
- Tool to accelerate video analysis
- Video surveillance technologies to assist operators of critical infrastructure
- Operators' needs for explosives detection at locations that have a secure perimeter
- Guidelines for preventing ATM attacks and for physical ATM security
- Training of the staff who perform real-time monitoring of building alarms and CCTV covering the area around an ATM
- Raising quality in Explosive Detection Dog (EDD) services
- Key principles and guidelines on the use of EDD
- Automated dog trainer devices
- Contactless close- and long-range sensors for trace explosive detection on surfaces and concealed threat detection.

training, well-developed and exercised SOPs, and mechanical and logistic support. For some of the selected scenarios cost-effective measures that can be widely and easily implemented,

and give a real benefit, could for example be increased awareness of indicators of IED emplacement, and improved surveillance with CCTV and EDD. Indicators of IED placement may

Photo: FOI

be detected by routine law enforcement activities that can intervene to prevent imminent bomb threats and stop the placement of a device. Security personnel or citizens may also be able to observe suspicious activity, such as someone leaving an unattended bag at a site, and notify authorities.

Exploration & Development of New Technology

A critical aspect to consider during the development of new technology for the detection phase is the ability to quickly adapt to the continuous development of the modus operandi regarding the methodology to perform an attack.

It is also important to consider and address the factors that might hinder the adoption of innovation (e.g., fragmentation of the market, low market visibility, cultural barriers on the demand side, and ethical and legal societal issues). It should be noted that innovation uptake can be a slow process full of decisions, usually taken by the buyers.

Together with the technical development of new technology, its validation for the intended use and the cost-effectiveness assessment, some ideas which have been brought up for actions could be EU standardisation activities to best support user need, and enabling of common access to data sets at the EU level.

Collaboration

Not only government initiatives (i.e., public funding or new legislation) are required for successful innovations in the long run. A successful future in the market can also depend on a genuine involvement, commitment, and partnership of potential clients in the security industry from the beginning. This would benefit a proactive collaboration between innovators and end-users of the technology.

Collaboration is essential to accelerate innovation at different stages and between various actors (e.g., governments, regulators, policymakers, industry, innovators, researcher teams, and users).

Photo: Harland Quarrington, OGL v1.0OGL v1.0, via Wikimedia Commons

MITIGATE

The possibilities to mitigate the effect of explosives are independent of the underlying motivation of a perpetrator. Here, we highlight the importance of protecting existing infrastructure and striving for it during planning and construction. Quantitative risk analysis is one available tool that can guide the decision process by balancing costs and effectiveness.

RESEARCH INITIATIVES

Countering terroristic attacks in the mitigate phase at public spaces, critical infrastructures and buildings of interest is well-established and has been a major field of research in the past and now. For example, the RIBS-project supported the design of effective and viable integrated security measures protecting infrastructures without affecting their business dynamics. VITRUV (Vulnerability Identification Tools for Resilience Enhancements of Urban Environments) contributed to enabling the development of more robust and resilient spaces in the field of urban (re)planning/ (re)design/ (re)engineering. SPIRIT (Safety and Protection of built Infrastructure to Resist Integral Threats) aimed at developing tools to reduce damage, destruction, and disruption to large new and existing buildings.

However, the well-established measures and technologies that could be applied with respect to a large part of the scenarios are not really suitable since these attacks can occur everywhere, and a comprehensive implementation is not economically feasible. As such, these measures are also not mentioned in respective design- or building codes. Further research to handle these attacks in the mitigate domain does not appear as promising as research in other counter-attack domains.

Photo: redspotted from London, UK, CC BY 2.0, via Wikimedia Commons

ED Neutralization

Mitigating attacks by criminals through IED neutralization is from a technological point of view similar to terroristic motivated attacks. With respect to the neutralization of IEDs, SUBCOP developed technologies and procedures that can be applied by the Police Security Forces when responding to a suspected PBIED (Person Borne Improvised Explosive Device). In ENCOUNTER, besides innovative techniques for mitigation of IED effects, the neutralization of IEDs in urban/civil environment was investigated. The outcome of research projects and IED neutralizing technologies can help mitigate explosion effects in the criminal use of explosives domain.

Protection of ATMs

Technological and organizational solutions protecting ATMs and their surroundings from explosions effects are in principal available, but not widely applied due to financial reasons. ATMs that are targeted in attacks are typically just removed or moved to safer locations.

Evacuation

Regarding the scenario with misuse of pyrotechnics, preventive measures are strongly recommended and seem to be the most promising. To mitigate the physical effects of these pyrotechnics, using structural measures is probably not applicable or necessary because of the small effective radius of such devices (compared to larger IEDs with high explosives). These pyrotechnics can cause significant injuries to people in the close surroundings and e.g. cause dangers such as mass panics. Therefore, organizational measures such as evacuation could mitigate the effects of these attacks.

Further Research

A field for further research could be the identification of simple and cheap technological and organizational measures to mitigate explosion effects. The basis could be quantitative risk analysis, where different kinds of measures, their costs, and effectivity are evaluated against each other.

Possible suggestions to better mitigate the effect of explosives:

- Resilient and robust building solutions during urban planning and design
- Protect infrastructure (reduce damage and destruction) with business dynamics in mind
- Identify technological and organisational measures to mitigate explosion effects on ATMs
- Quantitative risk analysis to balance costs and effectivity
- Evacuation plans to mitigate secondary harm to a crowd in panic

React
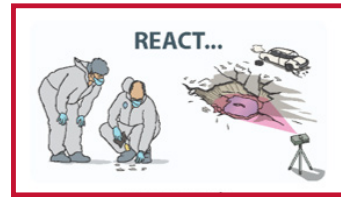
REACT...

The catalogue of potential options to react to the criminal use of explosives is broad; it covers legislation, police communication, surveillance of physical places and the cyberspace.

Challenges & possibilities in React

The different scenarios pose different challenges for the react domain. The scenarios with financial gain as motive, especially attacks on ATMs for cash, might be countered by improved CCTV inside and outside banks and ATMs. In addition to better surveillance, safety measures in the ATM could be enhanced by e.g. explosion- and flameproof enclosures.

To further discourage from ATM attacks, ATMs could be adapted to be able to invalidate banknotes by automatically staining them with paint and marking them with artificial DNA when they are subject to an attack. A priority is also the protection of ATM maintenance teams. The use of body- and dashboard cameras, mobile alarms or emergency buttons

Photo: Bernhard Zachhuber, FOI

could have a deterrent effect, and might also provide information to the law enforcement, to intervene during the attack or as evidence afterwards.

One of the scenarios considers money extortion. Although the options to react to this scenario is seen to be limited, one possibility is for the police to establish or intensify communication and cooperation with local businesses (i.e., the victims).

In another scenario, explosives and pyrotechnics are misused for personal gain at a football stadium. To counter these incidents the entry controls and surveillance at stadiums could be intensified. Effective countermeasures from the detect phase which could also help in the react domain include specialised dogs, personalised tickets, and improved CCTV inside and outside a stadium. Improved communication between police, fans, and football clubs could also aid in countering this scenario.

For all scenarios that involve explosives stolen from an explosives storage, enhanced protection of these storages could provide an important

The following concepts are thought to allow to react better:

- Automated footage analysis that identifies relevant individuals and reconstructs a sequence of events

- Forensic lab that optimises evidence collection through in-situ evidence analysis

- 3D-scanner that records and analyses footwear and tyre impressions

- Development of analytical tools that chemically profile explosives in forensic casework

countermeasure. If combined with possibilities for tracking and tracing the explosives, the amount of used in IEDs might be reduced even further.

Improved and more extensive monitoring and surveillance of the trafficking of ammunition, pyrotechnics, and precursors on the darknet, could reduce the number of attacks. In addition, the surveillance of social media could be intensified.

Standardization and certification

Regarding classification and certification, higher requirements for dealing with and possessing specific types of pyrotechnics could limit the use. Currently, the classification of pyrotechnic products is not homogeneous throughout Europe, and one solution could include a unified European approach that classifies threats from commercial pyrotechnics via reproducible measurements.

Legislation and regulation

For increased legal certainty and more efficient processes, courts could have prosecutors and lawyers specialised in explosives and simplify access to expert advice from explosives specialists. Moreover, convicting evidence may be found faster through improved cooperation between organisations and authorities.

Photo: Public domain, via Wikimedia Commons. File:USMC-071129-M-1013R-004.jpg

Concluding remarks

During this last year, the EXERTER network has tried to find ways to interact and share experiences, despite the covid-19 situation preventing us from meeting. Two virtual workshops and a virtual conference provided a forum for many discussions and exchanges. National discussions were held with stakeholders and practitioners, resulting in many requirements and suggested recommendations for improvements.

The focus within the Prevent counter attack-domain this year was identifying research initiatives working on related issues, such as collaboration platforms for exchange of experiences, video surveillance, or detecting smuggling of explosives substances. Many of the recommendations lifted within the network this year concerned smuggling, legislation and education on the risks with, for example, pyrotechnics.

The Detect phase highlights research projects connected to improved canine detection, CCTV surveillance, and other detection methods for explosives and weapons. It lifts the importance and difficulty of detecting and identifying a threat and pinpoints some ideas for identifying or discouraging the perpetrator.

A challenge in Mitigation for this year's scenario is how to mitigate against a threat that can occur anywhere and in ordinary buildings. Many research projects and measures exist with the focus on mitigating effects on critical infrastructure and facilities of interest, but such measures would not be economically feasible to apply in general buildings. For the protection of, for example, ATMs, some ideas are lifted to mitigate the effects and concepts to limit the impact of pyrotechnics use.

In the React domain, a lot of focus was put on the importance of forensics analysis and improving communication between different actors. The aftermath of an incident is also closely connected to the other work on surveillance and on preventive measures to give a better toolbox to work with.

Please visit our EXERTER's web-page, or contact us for more information about our work and activities.

EXERTER consortium