ENCIRCLE

EuropeaN Cbrn Innovation for the maRket CLustEr

ENCIRCLE DRS04 CBRN STATE OF THE ART INNOVATIONS

Dissemination level

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Executive Summary

This report provides a summary of the status of the CBRN DRS04 State of the Art Research as of November 2021

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1 INTRODUCTION

The main goal of the ENCIRCLE project is to strengthen the European industry to help create the tools and strategies needed to consolidate the EU CBRN communities of suppliers and practitioners in order to strengthen the field of CBRN safety, security and defence in the European Union.

In order to achieve this goal the innovative approach based on the five objectives aimed at prompting the innovation and business development, and filling market gaps in the project timeframe was proposed. The project objectives include:

- Create an open and neutral EU CBRN cluster,
- Provide a sustainable and flexible vision and roadmap for the development of the European CBRN market and innovations,
- Provide integration with platforms (systems, tools, services, products) by proposing standardized interfaces and future EU standards to integrate CBRN technologies and innovations developed from the Part B projects,
- Support CBRN safety, security and defence commercial and market services,
- Improve and facilitate European CBRN dissemination and exploitation.

This report provides a summary of the status of the CBRN DRS04 State of the Art Research for 2021
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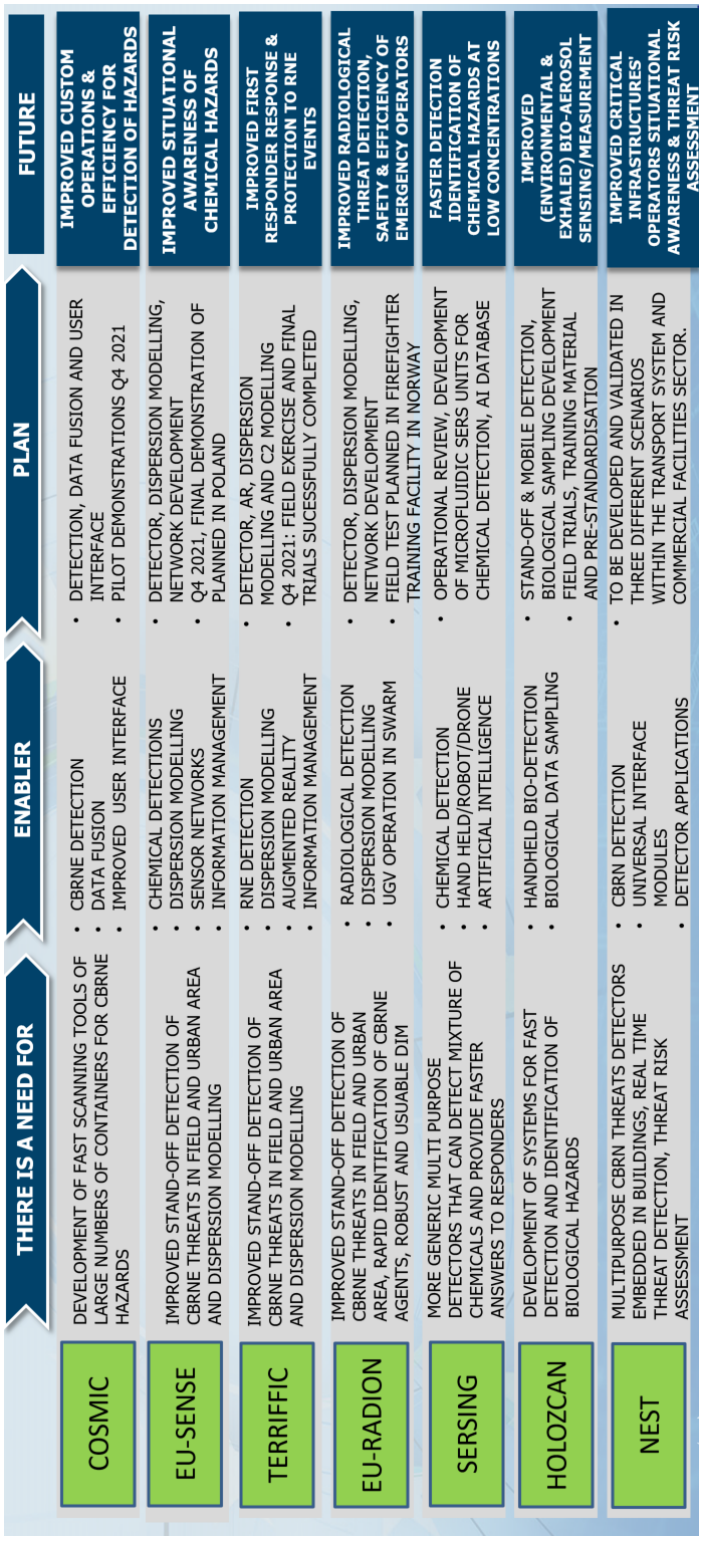
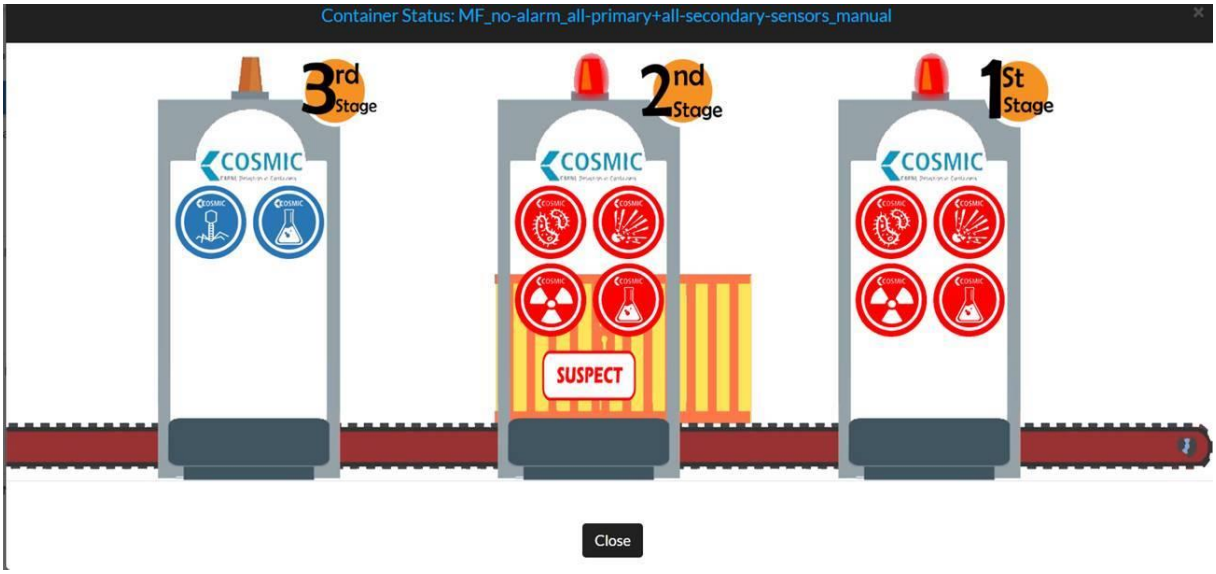
2 DRS04 PROJECTS STATE OF THE ART SUMMARY

The following diagram summarises the innovations being developed by the DRS04 projects and the following subsections provide a summary of the CBRN innovations:



2.1 COSMIC

COSMIC: CBRNE Detection in Containers
Start Date: Q4 2021
End Date: Q4 2021



2.1.1 Objective

The threat of CBRNE (Chemical, Biological, Radiological, Nuclear and Explosives) components used by terrorists is major concerns for EU and worldwide security. Today there is a major security gap in the existing security flow that can be used by terrorists to hide and smuggle CBRNE materials inside containers and vehicles. The challenge of improving container and vehicles border crossing and critical infrastructure entrance security checks is of great importance in fighting terrorist threats, theft and smuggling. Improvised Nuclear Device (IND) could be detonated using nuclear weapon components, modified nuclear weapons, or a self-made device and Radiological Dispersal Device (RDD) could be designed to disperse radioactive materials through an explosion (or 'dirty bomb').It was also reported that since 1998, in the US alone, there have been more than 1,300 reported incidents of lost, stolen, or abandoned devices containing sealed radioactive sources, an average of about 250 per year. Chemical and Biological are in use by terrorists. Report of Wm. Robert Johnston summarizes the "historical attacks using chemical or biological weapons" with 23 attacks since 1994, while all the recent attacks were done mainly by terrorists and the Syrian militants. The attacks demonstrating the attempts and capability of terrorists to acquire chemical and biological materials (chlorine, mustard, sarin, etc) and to prepare chemical or biological bombs. 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

2.1.2 Capability need being met:

COSMIC will provide improved capability for the faster detection of CBRNE materials hidden in shipping containers.

2.1.3 Expected improvement in capability/need at the end of the project

By the end of the project COSMIC will provide improvements in the detection of

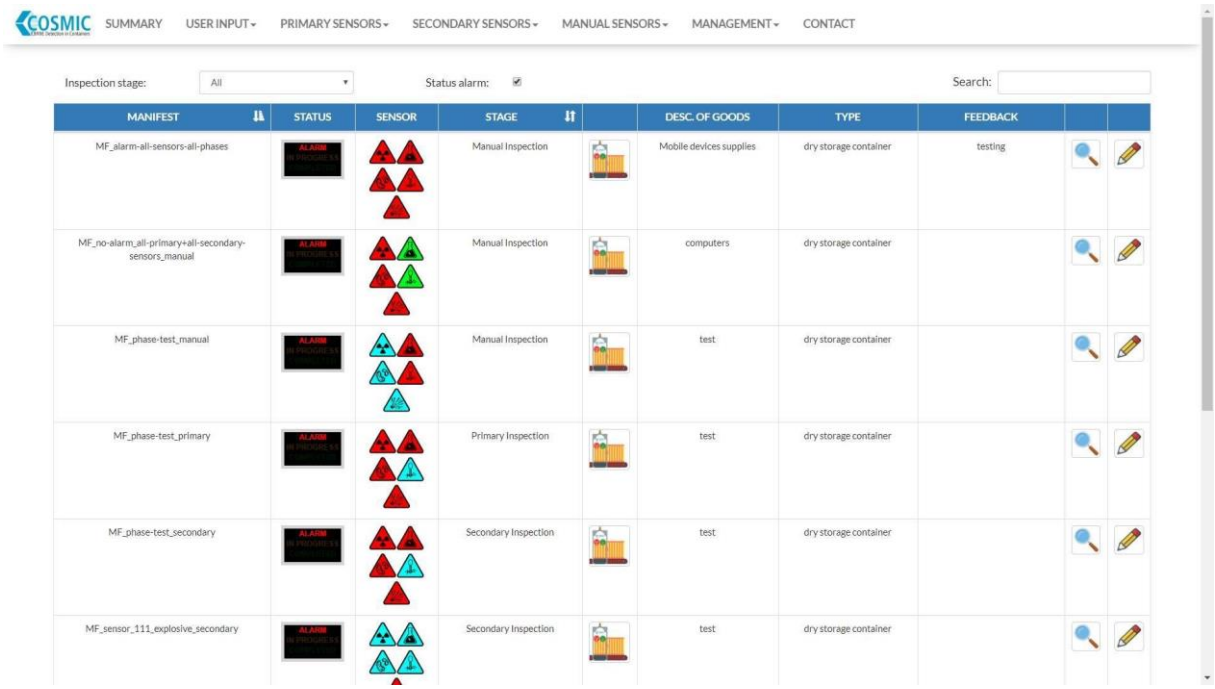
- Explosives
- Chemicals
- Nuclear / radiological
- Bacteria
- Virus

Improved Risk analysis from the fusion of data collected from sensors and the information of the manifests

2.1.4 Innovations/Tools developed and their TRLs at end of project

The following innovations and tools have been developed

- Radiological detection TRL7
- Explosive detection TRL7
- Bacteriological detection TRL6
- Virus Detection TRL4
- Data fusion among sensors and manifest data TRL6



2.1.5 Demonstrations and trials

Testing of Muon Scanner, 3 scenarios tested - - Haifa seaport Field-Trial

Explosive detection sampling completed at Valencia seaport and chemical detection sampling conducted at Rotterdam seaport.

Laboratory and simulated field trials conducted for Biological and Virus detection

2.1.6 Project and Contact Details

CORDIS: Link
Project website: Link
Video: Link

2.2 EU-SENSE

EU-SENSE: European Sensor System for CBRN Applications
Start Date: May 2018
Finish Date: Q4 2021

2.2.1 Objective

The EU-SENSE project will provide an innovative technical solution to deal with selected shortcomings in CBRNe protection indicated in the ENCIRCLE Catalogue of Technologies. The created system will be a step-forward in chemical detection by developing a novel network of sensors that exploits advanced machine-learning and modelling algorithms for improved performance.
The salient objectives of the project include development of an adaptable and multipurpose threat detection system (network of sensors, comprising both stationary and person-worn sensor nodes supported by environmental noise learning algorithm for false alarm rate reduction) and tools for enhancing situational awareness based on the sensor data (threat source location estimation and hazard prediction solutions). In general, the developed system will improve the threat detection capabilities and will increase state-of-the-art sensors reliability by networking and novel algorithms. Moreover, the project will implement a dedicated mode covering CBRNe practitioners training aspect. The mode will be an integral part of the system and will allow for familiarization with the equipment (the system) as well as training and rehearsal for specific situations.
The EU-SENSE will be strongly user-driven and the demonstration of the developed system will be conducted in the realistic working conditions, in the professional firefighters training centre and with the use of chemical simulants. The project will also consider the issue of interoperability between various chemical sensors and will propose a concept for standardisation of sensor network description.

2.2.2 Capability need being met:

- Real-time detection, monitoring and analysis of threats and hazards - the ability to detect, monitor and analyse passive and active threats and hazards at scenes in real time
- Rapid identification - the ability to rapidly identify hazardous agents and contaminants
- Actionable intelligence – the ability to create actionable intelligence based on data and information from multiple sources
- General need to raise the CBRNe awareness of first responders and others (e.g. by training and education)
- Updated (and regularly exercised) CBRNe emergency preparedness plans for private and public entities

2.2.3 Expected improvement in capability/need at the end of the project

The expected improvements from EU Sense are:

1. The EU-SENSE proposes the design and development of a sensor network system, which will allow for improved real-time on-scene chemical detection.

2. The use of heterogeneous sensor nodes, comprising sensors incorporating various detection technologies (i.e. IMS, FPD, PID, EC, and MO), will allow for rapid and proper identification of a wider spectrum of chemical agents.
3. A part of the system includes data fusion and machine learning algorithms that will post-process the measurement data from the sensor nodes. This data processing allows to reduce the impact of environmental noise on the sensor readouts and perform classification, identification and concentration estimation. As a result, false positive/negative alarm ratio will be reduced.
4. Thanks to the training mode feature, end users will be able to experience a real-world incident and enhance their decision making capabilities by using a simulation tool supported by pre-defined synthetic data being influenced by machine learning algorithms.
5. Users of the EU-SENSE system will be given an option to operate the system in a training mode and conduct training sessions with realistic simulations according to the selected scenario.

2.2.4 Innovations/Tools developed and their TRLs at end of project

The following innovations will be available at the end of the project:

- **EU-SENSE Sensor Node** – a microcontroller device, which has been developed within the project. The node integrates various sensors through a dedicated interface and merges the data into a single data frame. The node wirelessly transmits the data to the network controller.
- **Network of chemical sensors** – the EU-SENSE network is a final, integrated product of the project combining data collection, computational, visualisation and management layers of the system. Operational network system will be showcased during the final demonstration.
- **Environmental Noise Learning Tool** – a software component that utilizes machine learning to filter the environmental noise and, as a consequence, reduce false alarm rate.
- **Source Location Estimation Tool** – a software component responsible for calculating chemical threat source location.
- **Hazard Prediction Tool** – a software component responsible for the calculation of the most probable dispersion model of the contaminant.
- **Situational Awareness Tool** – a user-access point that collects the data from various components and integrates them into the situational view.
- **EU-SENSE training mode** – the EU-SENSE system mode that is dedicated for training purposes. It utilizes computational components and artificial data in order to provide a realistic simulation environment.
- The EU-SENSE network system comprises numerous hardware and software components, which are currently at a different technology level. As a consequence of the research and development performed within the project, the complete platform is evaluated at TRL 6.

2.2.5 Demonstrations and trials

On 6th and 7th October 2021, the final demonstration of the operational EU-SENSE system was held. The demonstration was organized by the Main School of Fire Service, during which a practical

presentation of the system was showcased at the Training and Rescue Innovation Base in Nowy Dwór Mazowiecki. During the demonstration session, the consortium showcased the operation of the system in two different scenarios: a mass incident (crisis preparedness phase) and a toxic industrial incident (ammonia leakage, crisis response phase). The demonstration proved that the EU-SENSE system can be used in various crises and outlined further directions of its development.



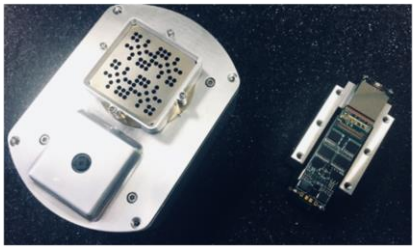
2.2.6 Project Contact details and Links

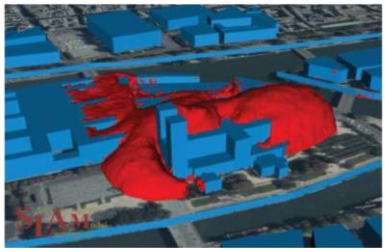
- CORDIS: Link
- Project Website: Link
- Demonstration Video: Link

2.3 TERRIFFIC

TERRIFFIC: Tools for early and Effective Reconnaissance in cbRne Incidents providing First responders Faster Information and enabling better management of the Control zone
Start Date: May 2018
Finish Date: Q4 2021







2.3.1 Objective

The TERRIFFIC project will deliver a step change in the effectiveness of first responders during the first hours of a Radiological, Nuclear, explosive (RNe) incident. It will lead to reduced response time, less health and safety risks for the response team, and less human intervention in the operation due to higher number of automated processes and extended mobile detection capabilities. TERRIFFIC will enrich the European response to RNe events by a set of modular technology components in a comprehensive system, incl. new detectors, algorithms, drones, robots, dispersion models, information management software and decision support systems. The project will provide detailed information on the applicability of some developments within a chemical and biological (C/B) context.
Dedicated Key Performance Indicators will measure the progress towards targeted performance goals, such as significant acceleration of the time to start terrain interventions due more accurate and near-to-real-time estimation of the control and exclusion zones. Advanced mixed reality technology will be leveraged to provide first responders with ad-hoc available and continuously updated information during operations.
TERRIFFIC is SME-led and practitioner-driven. Leading edge technologies will be provided by the R&D partners, whereas key innovative components will be developed by SMEs already involved in military or first responder markets taking on the commercialisation of the TERRIFFIC System and its components. The practitioners will be strongly involved throughout the development process, components assessment and technology trialling.
The project will leverage results from previous successful FP7 projects, closely cooperate with ENCIRCLE on the CBRN Cluster and market aspects, and with eNOTICE on training and technology testing and assessment. Special attention will be given to standardisation to optimise the integration with future and already applied solutions.

2.3.2 Capability need being met and expected improvements

The solutions provided by the TERRIFFIC project are tailored to the needs of practitioners and will allow for less human intervention in a CBRNe response operation, due to the higher number of automated processes and improved and extended mobile detection capabilities in the ‘hot zone’.

Improved situational awareness and the delivery of near real-time data within the TERRIFFIC System will result in a better Common Operational Picture. This will enable incident commanders to gain a

better understanding of the nature and scope of the threats and therefore make better-informed decisions.

The TERRIFFIC System and its core components are highly mobile and can be deployed quickly. The tactical incident management system installed on the mobile van will be initiated whilst en route. The van will also be equipped with easy to set up ground detectors for immediate deployment, as well as having handheld beta detectors on board for use, once the initial assessment of the risks has been completed.

Specialist UAVs, able to fly in heavy rain and wind gusts of up to 90kph, with the world's smallest gamma cameras and new sensors attached, can be operational within minutes and fly into the hot zone to identify the location, size and type of the source. With traditional drone cameras attached, they will also be able to spot potential victims and communicate visual data about damage and people needing assistance.

UGVs with the same TERRIFFIC sensors and gamma cameras can be sent into the hot zone to obtain further data closer to the source. The data that these sensors provide will be used to create a plume modelling forecast, which will give a more accurate and dynamically updated determination of the contaminated area and the control area. The plume modelling algorithms have been specifically designed for use in complicated urban environments and take into account the wind, weather and surrounding buildings, all of which will affect the spread of the radiation.

All of these tools send information into the Augmented Reality solution and the incident management software concurrently. This greater knowledge results in a greatly improved level of situational awareness, a reduced risk profile and a higher level of safety for first responders.

It has never before been possible for a CBRNe incident commander to be able to access so much data in near real-time. The TERRIFFIC System has the potential to have a significant and genuine impact on how an RNe incident is managed by first responders and to save lives both of practitioners and members of the public.

2.3.3 Innovations/Tools developed and their TRLs at end of project

KER title	Expected TRL at project's end	Time to exploit[1]	KER Details
SiPR detector	TRL 7	1-	A SiPR detector reduced in weight and size, so that it can be mounted onto both a UAV and UGV to detect gamma radiation. This component will be based on an existing prototype from Arktis Radiation Detectors (at TRL4 at start of project).
Gamma camera	TRL 7	1-	Design and development of a gamma camera, significantly reduced in weight and size, so that it can be mounted on UAVs and

[1] 0 = immediate
1- = less than 1 year
3- = 1+ to 3 years
3+ = more than 3 years
? = cannot be specified

			UGVs to detect gamma hot spots. Novel development by CEA (camera was at TRL4 at start of project).
UAV	TRL 9	0	Aeraccess' Unmanned Aerial Vehicle (UAV) Q800X, which includes autopilot function and mission automation, allowing for integration of miniaturised payloads to detect radiation outdoors, while being compatible with common decontamination techniques. Currently TRL9, however the TERRIFFIC project will support further developments with respect to the coordinated use of UGV and UAV for a common operation in swarm mode.
UGV	TRL 9	0	An unmanned ground vehicle (UGV), incorporating the integration of various detectors, piloted automated exploration and manipulation tasks. Based on Nexter Robotics' Nerva-LG robot (current TRL9, however, TERRIFFIC will support further developments with respect to autonomous exploration modes and automatic search capabilities that enable the locating of maximum levels of radiation and contamination).
Plume modelling software	TRL 7	1-	Development of Ecole Centrale de Lyon's 'Safety Lagrangian Atmospheric Model' – SLAM. Atmospheric dispersion modelling software used to simulate the plume of pollutants and the area of danger, and inverse dispersion modelling software used to evaluate the location of the source and the quantity of release.
Incident management solution	TRL 7/8	1-	Information Management and Decision Support System providing data fusion and tactical information capabilities with open modelling APIs for interfacing with the plume model and extended detector integration with open detector APIs. This core component is based on Bruhn NewTech's product 'CBRNEFrontline'.
Augmented Reality software	TRL 7	3-	A collaborative augmented /mixed reality environment using as its core component the Luxembourg Institute of Science and Technology's mixed reality solutions (utilising the Apple ARKit).
Mobile radiation detection van	TRL 7	1-	A mobile van equipped with improved radiation detection technologies and enabling the integration of tactical information systems. Development of Arktis Radiation Detectors' MODES van, initially developed in the FP7 project MODES_SNM.
Handheld Beta detector	TRL 7	1-	A handheld detector allowing for discrimination of beta and gamma radiation levels. A novel development by CEA (TRL2-3 of beta / gamma discrimination detectors at start of project).
Neutron detector	TRL 7	1-	A portable neutron detector that can be integrated into the mobile radiation detector van above. Based on Arktis Radiation Detectors' M1000 large-area neutron detector.

2.3.4 Demonstrations and trials

The fully integrated TERRIFFIC System was thoroughly tested in the last two trials with CBRNe practitioners in September 2021. The System was put through its paces firstly in a tabletop and field exercise in Slovakia and then again two weeks later in the final trial in France.

The Field Exercise was held in Malacky, Slovakia on 07-08 September with a hot debrief the following day. The practitioners were able to see and use the integrated TERRIFFIC Project System, using genuine radioactive sources in realistic operational scenarios. The police and fire officers were able to experience first hand the tangible benefits of the TERRIFFIC System, which uses innovative gamma and beta sensors and a new gamma camera, mounted on both UAVs and UGVs. There was also a new beta handheld detector used to locate and identify the sources.The sensor results and plume modelling forecasts were automatically fed through into the augmented reality solution, using Microsoft's HoloLens glasses, and into the incident management system in the specially-equipped MODES van.

This was real proof of the power of using innovative technology in an RNe incident to help CBRNe officers manage the event more effectively – and greatly reduce the risks to personnel.

The Final Trial was held in Chambéry in the Savoie region of France on 29-30 September and kindly hosted by SDIS73, fire officers were able to assess the complete TERRIFFIC System in an operational setting using a variety of real radiation sources. In Chambéry, fire officers first used their existing procedures to conduct searches for the radioactive sources and the exercise was repeated using the TERRIFFIC System using different scenarios and different source types, so that they could better assess whether the System could offer them tangible benefits.

In mid-October, the project successfully held their final Public Workshop in Aix-en-Provence. The hybrid meeting also included a demonstration afterwards at ENSOSP, the French fire officers' college, and again the next day at the 127th Fire Congress.

2.3.5 Any support required

- None required

2.3.6 Project Contact details and Links

- Cordis: Link
- Project Site: Link
- Video: Link
- **Project Coordinator – Ulisse Gendotti, ARKTIS Radiation Detectors**
- gendotti@arktis-detectors.com
- **Project Communication and Media Contact – Rob Munro, ARTTIC**
- terriffic-arttic@eurtd.com
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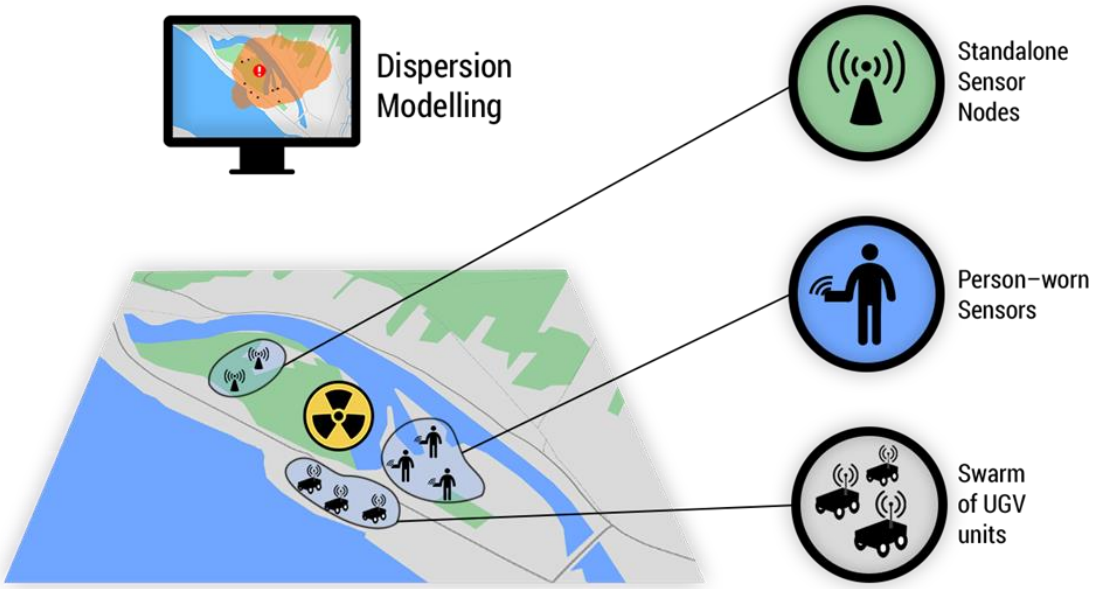
2.4 EU-RADION

EU-RADION: European System for Improved Radiological Hazard Detection and Identification



2.4.1 Objective

The EU-RADION project will provide an innovative solution to deal with selected shortcomings in CBRNe protection indicated in the ENCIRCLE Catalogue. The project will provide an operational radiological threat detection and identification system comprising several technological components. The components encompass radiological threat dispersion modelling and analysis tools, test sensor platforms including swarm of mini UGVs, tactical command tool, network controller and sensor integration unit.

The sensor integration unit (SIU) will be a novel detector, which includes several radiological threat sensing devices supported by hydrogen sensor and positioning module. The SIU will be adaptable to several platforms (including stationary, handheld and UGV mounted units) and capable of operating in both indoors and outdoors environments. Furthermore, the system will feature a computational tool allowing for estimating the dispersion of RN material and its potential source. Moreover, the Tactical Command tool (TC) will be the highest layer of the system responsible for providing a user interface to the system and integrating data acquired from measurement and computational components. This component will cooperate directly with the network controller (NC) in order acquire data from radiological sensors. EU-RADION also assumes the implementation of UGV swarm concept for radiological threat detection and evaluation of its performance in CBRNe domain. EU-RADION will be based on system-of-systems approach. All of the developed components will be designed as fully operational and independent modules. This will enhance the system interoperability and facilitate potential integration with other existing systems. The final system will be demonstrated in realistic environment (training tunnel).

2.4.2 Capability need being met:

- Real-time tracking of responders - the ability to know the location of responders and their proximity to threats and hazards in real-time
- Real-time detection, monitoring, and analysis of threats and hazards - the ability to detect, monitor, and analyze passive and active threats and hazards at scenes in real-time
- Rapid identification - the ability to rapidly identify hazardous agents and contaminants
- Integration of information - the ability to incorporate information from multiple and non-traditional sources into incident command operations
- Remote acquisition of information - the ability to obtain critical information remotely about the extent, perimeter, or interior of the incident
- Individual detection equipment for first responders (CBRN dosimeter + detection system)
- General need to raise the CBRNe awareness of first responders and others (e.g. by training and education)

2.4.3 Expected improvement in capability/need at the end of the project

The expected improvements from EU-RADION are:

1. The EU-RADION project develops a navigation module for both hardware and personnel deployed in the field to estimate their exact position and proximity to the detected hazard and its propagation. The navigation module should allow for positioning of the assets in a GNSS denied environment.
2. A novel wireless network of RN sensors combined with data fusion algorithms will allow for real-time monitoring, and identification of the radioactive hazard as well dispersion model calculation and threat source estimation.
3. The Sensor Integration Unit (SIU) developed during the project will be able to detect ionizing radiation, identify the specific isotope, and monitor it in real-time. What's more, its wireless communication with a central Network Controller and Tactical Command (TC) tool will allow for fast hazard data transmission enhancing the situational awareness and decision-making process.

4. The above-mentioned Network Controller will have the ability to acquire data from all the SIUs present on the incident scene and will provide an Application Program Interface (API) for potential integration with existing emergency response software systems allowing all the data to be transparently gathered in one Tactical Command tool.
5. The SIU will be adaptable to various platforms, i.e. stationary, person-worn, and Unmanned Ground Vehicles (UGVs). The swarm of dedicated UGVs will be developed as a part of the EU-RADION project so that remote detection and identification of the RN hazard is possible without endangering any of the responders.
6. The system will offer functionality that allows it to calculate the dispersion trajectory model of radioactive material and estimate its potential source, as well as estimate the radiation dose rate at a given position.

2.4.4 Innovations/Tools developed and their TRLs at end of project

The following innovations will be available at the end of the project with a minimum maturity of TRL5::

- **Sensor Integration Unit** – stationary/hand-held units combining gas and radiological sensors for real-time threat detection and identification.
- **Navigation unit** – a tracking module based on inertial and GNSS sensors developed for precision location and navigation of first-responders and other EU-RADION assets.
- **Swarm of UGVs** – UGV swarm for unmanned, remote detection of RN hazards in the area of interest will be developed within the project.
- **Unified Data Model** – a standardized description of the EU-RADION communication messages and data structures format, which can be reused for further extensions of the system.
- **Tactical Command tool** – a user-access point that will collect data from various components, and integrate the results into the joint operational view.
- **Dispersion modelling** – a computational tool processing sensor measurements and calculating the threat map model (dispersion) and source estimation of the hazard.

2.4.5 Planned demonstrations and trials

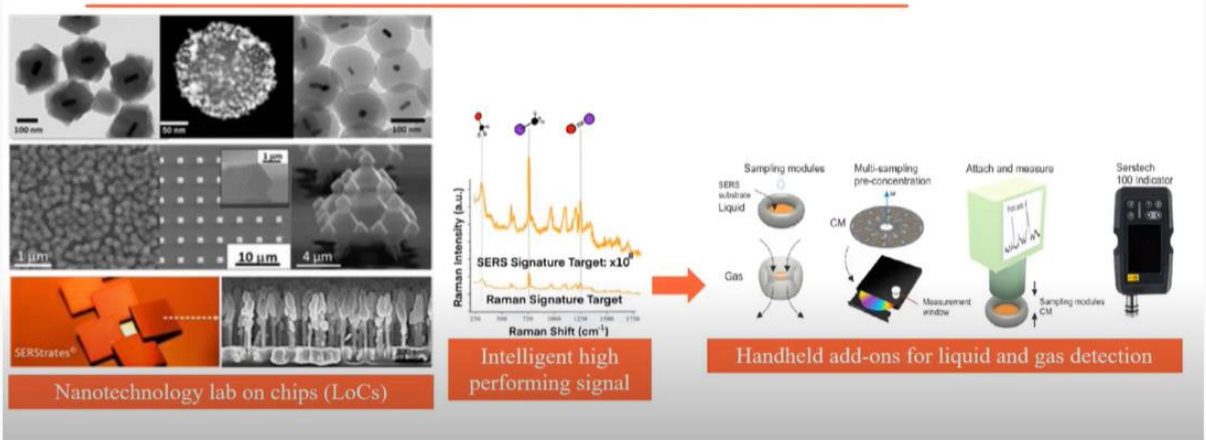
There will be field tests of the EU-RADION system, most of them conducted in a training facility for firefighters in Norway in the Runehamar Test Tunnel.

2.4.6 Project Contact details and Links

- Cordis: Link
- Project Site: Link
- Video: Link

2.5 SERSING

SERSING: Advanced Surface Enhanced Raman Spectroscopy (SERS) based technologies for gas and liquids sensING in the area of chemical protection
Start Date: 01-07-2020
Finish Date: 30-06-2020



2.5.1 Objective

The ultimate goal of SERSing is to enable fast detection and unequivocal identification of chemical hazards at low concentrations in gas and liquid phase, in multiple environments. The geo-located acquired data are submitted to an on-line learning platform and processed, transmitting threats and hazard data to authorized personnel and generating alerts on the incident scene in real time.
The innovative microdevices for detection and identification are integrated in low weight hand-held Raman equipment, specifically customized to overcome the common operational limitations of first responders, compatible with Personnel Protective Equipment PPE and respirators, easy to use and maintain with low cost of consumables. The robust, reliable, ultrasensitive lab on chips (LoCs) for on-site detection of chemical threats in gas and liquids are based on Surface Enhanced Raman Spectroscopy (SERS). The customized Raman spectrometer will combine geo-location and communication technologies specifically adapted for the rapid screening of the incident scene. This miniaturized platform could be also mounted on robotic units to inform operational command on possible chemical agents in preparation of entering the incident scene where the deployment of personnel is difficult.
These SERS LoCs and the adapted Raman are also envisioned as complimentary forensics tools and technologies that can be used: i) “on scene” to determine the chemical nature of a sample in order to collect it for further laboratory analysis or dismiss it; or ii) “in a laboratory environment” for profiling chemical agents released at an incident and to identify signatures for improved attribution.

2.5.2 Capability need being met:

The SERSING project will provide high performance, low-cost SERS substrates that can be integrated into portable microfluidic sampling units for improved chemical detection and preparedness and response to security incidents that will be easy to use for first responders.

2.5.3 Expected improvement in capability/need at the end of the project

SERSING will provide fast detection and unequivocal identification of chemical hazards at low concentrations in gas and liquid phase, in multiple environments

2.5.4 Innovations/Tools developed and their TRLs at end of project

SERSING will provide the following innovations at TRL5/6

- High performance, low cost, Surface Enhanced Raman Spectroscopy (SERS) substrates
- Selectivity: Designed for direct/indirect SERS based monitoring of toxic industrial compounds and chemical warfare agents
- Easy Integration: The substrates can be integrated into portable sampling units
- Spatial SERS response uniformity: Stable, consistent, reproducible and homogeneous SERS réponse
- Durability: Shelf life >3 years
- Scalability: The fabrication process is highly scalable high volume manufacturing process
- Intelligent: Cloud computing and artificial intelligence for enabling AI based statistical models
- Easy to use add ons: Liquid and Gas detection

2.5.5 Planned demonstrations and trials

A framework is being set up to ensure efficient procedures of test and evaluation (T&E) of prototype and its components that will be performed later in the project. The report also reviews competing DIM technologies for chemical hazards, pin-points the existing technology gap and elucidates needs and requirements the SERSing technologies shall consider. At a later stage in the project, a total of four proof of concept demonstrations will be carried out. Field tests with the device are planned in two countries, to evaluate operational characteristics including ruggedness and user-friendliness

2.5.6 Any support required

Integrating the end-users' needs into the device's development is crucial for its successful implementation. Therefore, the project would benefit from collaborations in identifying end-users' needs, and what factors determine the success of implementation of this type of innovations.

2.5.7 Project Contact details and Links

- Cordis: Link
- Project Site: Link
- Video: Link
- Contact : https://sersing.eu/
- or sersing@catalyze-group.com

2.6 HOLOZCAN

HOLOZCAN: Deep Learning Powered Holographic Microscopy for Biothreat Detection on Field
Start Date: May 2021
Finish Date: April 2024

2.6.1 Objective

HoloZcan brings a new tool for security actors (police, relief workers, disaster managers, crisis managers, stakeholders responsible for public safety, critical infrastructure, and service providers) notably in the fields of autonomous detection and response capabilities.
The project will increase (environmental and exhaled) bio-aerosol sensing/measurement capability of CBRN practitioners by developing a high resolution, large throughput, automatic and highly portable detection system for making automatic classification of pathogens and particles.
HoloZcan develops of a novel holographic microscopy and imaging technology for rapid and cost-efficient screening of potential biological threats and unknown, potentially dangerous substances, combined with methods of artificial intelligence and machine learning. It establishes a framework of a dynamic feature selection and validation algorithm to support the continuous innovation capability of the system in the field of adaptive learning and database optimization for specific bioinformatic applications. The project also develops comprehensive and innovative means of respiratory, ventilation and environmental biological data sampling that can be used in real-time, standoff or in mobile bio-detection context.
The project indicates the HoloZcan technique versatility for a wide range of applications and demonstrates its technical feasibility. The project responses to the actual needs of European practitioners and technological gaps identified by the ENCIRCLE project as indicated in the ENCIRCLE Catalogue of Technologies and addresses several shortcomings of the current approaches to bio-

threat agent detection.
The HoloZcan project applies a flexible adaptive approach to design and CBRN practitioners are engaged as project partners or as external stakeholders in the process.

2.6.2 Capability need being met:

The primary capability need being met is a more efficient biothreat detection system which will provide:

- A high confidence system with rapid (minutes) detection capabilities.
- An easy-to-use tool for the operators with automated alarms in case of detection of a potential threat.
- A robust detection system, which can face all biological threats (including unknown threats).
- A mobile and fieldable systems for sampling and detection.
- A cost-effective solution that can be used repetitively without extra cost and dependence on external infrastructure.
- Solutions, which does not require expert knowledge in order to interpret obtained results.

2.6.3 Expected improvement in capability/need at the end of the project

HoloZcan will have a great improvement on European security and global level preparedness against biological threats through the introduction of smart-microscopy in the CBRN field. These improvements include:

- HoloZcan can be used routinely in environmental/urban contexts and in emergencies. As It is a fast and cheap detection solution that offers the potential to conduct measurements in the field instead of in a laboratory.
- Providing a very economical option in CBRN detection: a cost-effective and lightweight solution that uses simple and inexpensive hardware, while it relies on computation to digitally generate high-resolution images.
- This method can be optimized to complement existing CBRN detection procedures and can be deployed to inaccessible remote areas, such as rural and border areas. The device and method can be designed for use in a resource-poor laboratory setting and useable in point-of-care detection of biological threats.

2.6.4 Innovations/Tools developed and their TRLs at end of project

HoloZcan will provide the following innovation with a minimum maturity of TRL5:

- A high resolution, large throughput, automatic and highly portable detection system for making automatic classification of pathogens and particles
- Digital Holographic Microscopy and supplementary modalities for detecting biological hazards almost in real-time
- Development of comprehensive and innovative means of respiratory, ventilation and environmental biological data sampling that can be used in a realtime, standoff or mobile bio-detection context
- AI supported analytical method, calibration and validation techniques of separating biological and physical nano particulars and making automatic classification of the imaged bio-aerosols into pre-trained classes

2.6.5 Planned demonstrations and trials

The technical feasibility of the HoloZcan system will be demonstrated by a ground breaking prototype. Which will involve co-designing the pilot demonstration activities with the operational environment to ensure representative evaluation. The HoloZcan team is applying a scenario-based evaluation methodology where the verification and validation processes are defined according to the specific application domain and the specific use case. A training mechanism and train-the-trainer materials will be generated and communicated to familiarize the practitioners/users with the HoloZcan equipment and to support the CBRN practitioners so that they easily gain knowledge, skills and the required competencies. The HoloZcan project will also conduct pre-standardisation activities to speed up the system adoption, scalability and repeatability.

2.6.6 Any support required

The project is seeking an interactive collaboration to define Users' Needs based on questionnaires and against Scenario backgrounds. This will be conducted by involving police forces, Law Enforcement Agencies, Relief Workers, Disaster and Crisis Managers, Persons responsible for public Safety, as well as Service providers for Critical Infrastructures.

HoloZcan project's approach is to offer the larger Community of Users an opportunity to join our Stakeholder Program and effectively assist in product design and specifications. See the page : https://holozcan.com/stakeholders

The project is also seeking collaborations with university research centers that have nano printing capabilities and researchers working nanostructures creating field who can work with us on manufacturing optical microscope target.

2.6.7 Project Contact details and Links

Cordis: Link
Project Site: Link
Video: Link
Contact email: info@holozcan.com

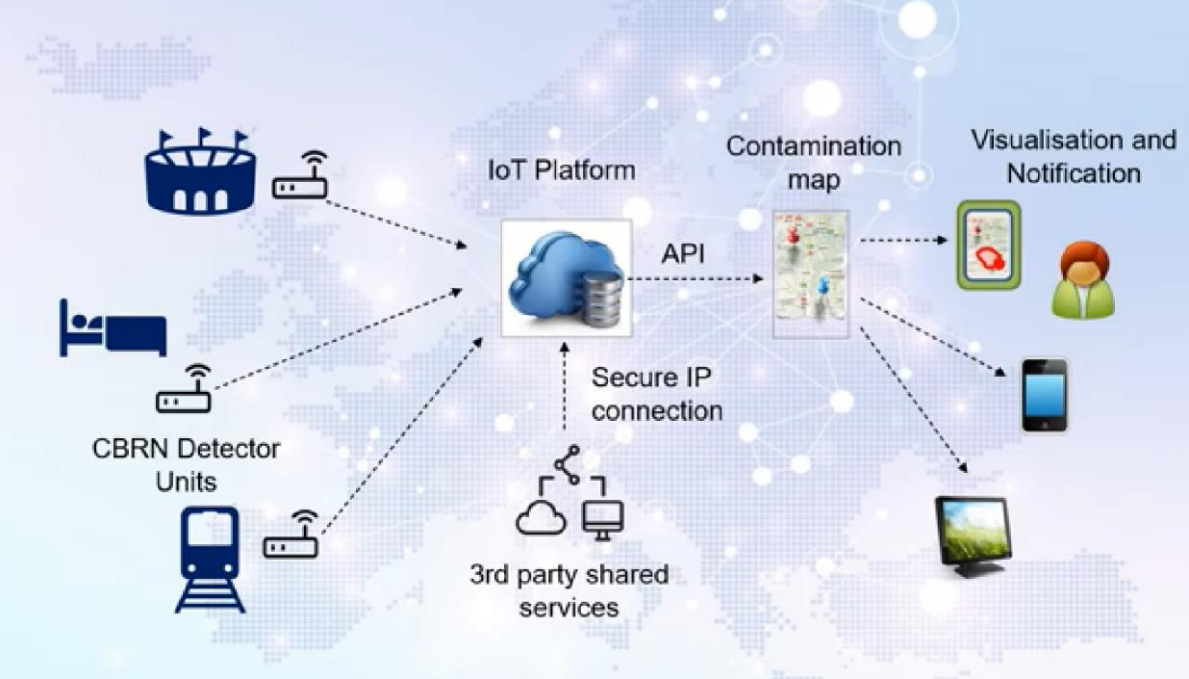
2.7 NEST

NEST: An iNteropErable multidomain CBRN SysTem
Start Date: May 2021
Finish Date: April 2024

2.7.1 Objective

NEST will design and implement a novel and unique standoff system with the capability to detect multiple threats amongst which CBRN threats or pandemic viruses. As the day-to-day protection of commercial and transport facilities is the responsibility of the owners and operators, in close cooperation with local law enforcement, NEST will support owners, operators, and security staff by providing (i) threat indications and warnings, and (ii) guidance for facility security by developing appropriate information-sharing and analysis mechanisms. The system will rely on the simultaneous use of low-cost CBRN detectors embedded in one unique detection equipment, which can be located

into different sites inside the building or carried by security staff. The use of low-cost sensors will enable to cover a wide space inside. NEST will help in the early detection of CBRN threats in real time, and also provide complementary information—such as such location of threats, temperature, humidity, time, operators involved, etc.—useful for auditing or investigation purposes. These functionalities will be achieved by using an IoT platform capable of acquiring, processing, and merging data from internal and third-party services. Artificial intelligence will be applied to support decision process for securing facilities and for generating automatic alerts. Furthermore, augmented reality will be used to display threats and hazards in a manner that minimise distraction and cognitive failures.
NEST will be validated in three different scenarios within the transport and commercial sectors. These scenarios include a diverse range of sites that draw large crowds of people. NEST will share information with the command centers of a stadium, a transport system, and a hotel to assess the risk situation. As a result of this action, owners, operators, and security staff will benefit from a universal system that will lay the foundations for creating a standardisation framework.



2.7.2 Capability need being met:

The system relies on the simultaneous use of low-cost CBRN detectors embedded in one unique detection equipment, which can be located into different sites inside the building or carried by security staff. The use of low-cost sensors enables to cover a wide space inside. NEST helps in the early detection of CBRN threats in real time and provide complementary information—such as the location of threats, temperature, humidity, time, operators involved, etc.—useful for auditing or investigation purposes. These functionalities are achieved by using an IoT platform capable of acquiring, processing, and merging data from internal and third-party services. Artificial intelligence is applied to support decision processes for securing facilities and for generating automatic alerts. Furthermore, augmented reality is used to display threats and hazards in a manner that minimise distraction and cognitive failures.

2.7.3 Expected improvement in capability/need at the end of the project

- Assist critical infrastructures' owners and operators with situational awareness and threat risk assessment at initial phases;
- Improve CBRN detection capabilities;
- Best practices in security and privacy;
- Standardisation to facilitate implementation at EU level.

2.7.4 Innovations/Tools developed and their TRLs at end of project

- **Universal interface module for sensing units:** A universal interface module (base unit) are being developed. This unit acts as a bridge between the different, individual monitoring units and the WAN and forms the basic unit that can be deployed in large numbers in case of an emergency. **TRL 6**
- **Chemical Detection Technology:** The chemical sensing units of NEST features a highly selective detection of individual gases based on a combination of three dedicated and tailored approaches. **TRL 6-7**
- **Biological Detection Technology:** The biological sensing units are being built using special active layers (constructed on electroactive materials - semiconducting organic materials), which are linked with highly selective antibodies. The antibodies binds antigens with high sensitivity and selectivity, producing a change in the electrical parameters and generating the signal. **TRL 7**
- **Radiological and Nuclear Detection Technology:** A monitoring unit for Radioactive and Nuclear contamination able to measure both total ionizing dose (TID) and thermal neutron dose are being produced. **TRL 6-7**
- **NEST Detector Platform:** The NEST Detector Platform are built upon the nAssist IoT platform (by S&C) designed and conceived to allow agile, continuous management of data in the energy efficiency, security, and automation fields. **TRL 7**
- **NEST Applications:** The NEST applications are designed in particular for a cyclic approach to response management, covering situational and risk assessment and decision support. The app for building owners and operators aims to improve risk awareness. **TRL 6**

2.7.5 Planned demonstrations and trials

The NEST solution will be validated by security managers in real environments against the operational Key Performance Indicators (KPIs) defined. The resulting user-centric value propositions will be contrasted against market opportunities identified to provide a reality check on exploitation strategies.
NEST will be validated in three different scenarios within the transport system and commercial facilities sector. NEST will share information with the command centers of a stadium in Poland and a transport system in Portugal and will provide information to update their own protocols. On the other hand, the security staff in the hotel in Spain does not have any protocol, so NEST will provide them with valuable information to assess the risk situation.
Following a detailed discussion between sensor experts and security experts, the consortium has opted for employing benign chemical agents (e.g. vaporized ethanol in concentrations below 1,000 ppm) to perform the demonstrations. On the one hand, this will allow for testing and validating all NEST functionalities in real-world settings. On the other hand, it will not require the specific security measures of RN sources neither will create a long lasting contamination of the test site like with B material. The field trials will realize different scenarios:

- Deployment of NEST after an attack with a warfare agent: A short pulse of the test gas will be released from one position and the NEST system will be deployed afterwards to perform measurements in the area.
- Deployment of NEST after suspected breach of critical infrastructure: A continuous flow of test gas will be released from one or multiple sites and the NEST system will be deployed afterwards. Based on the sensorial data a contamination map as well as indicators for the location of the source will be provided by NEST.
- Use of NEST to continuously monitor potential hazards: After deployment of the NEST system, test gas will be released from different sites. NEST should be able to provide an early warning as well as an indication of the point(s) of origin.

2.7.6 Any support required

NEST has required a **Security Advisory Board (SAB)** to identify and protect confidential information and share them only with the EC and with authorised users and stakeholders. The SAB includes both consortium members and external experts with expertise in the domain of risk management and safety procedure, information security and data protection.
In addition, an **Ethics Advisor** ensures that all research and innovation activities are performed according to ethical guidelines for research with human participants and in accordance with European Union fundamental values, such as the right to data protection recognised in the Lisbon Treaty. The Ethics Advisor is primarily responsible of drafting deliverables some deliverables and assess the fulfilment of ethical guidelines during the entire duration of the project.

NEST is designed for the managers of the critical infrastructures. Operational staff of these environments are the stakeholders that make the initial assessment of the situation, handle the early stages of the process and then make the transfer to the authorities that will handle the next steps. End-users are strongly involved through all the stages of the project to ensure that the technological developments are adapted to best fit their needs.

2.7.7 Project Contact details and Links

Cordis: Link
Project Site: Link
Video: Link