INGENIOUS

Enhancing Situational Awareness, Safety and Collaboration for the First Responder of the future

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OVERVIEW

INGENIOUS aims to assist First Responders (FRs) be more effective and save more lives during natural and manmade disasters and crises by exploiting novel technologies. INGENIOUS is developing, integrating, testing and validating a **Next Generation Integrated Toolkit (NGIT) for Collaborative Response**, which ensures high level of Protection and Augmented Operational Capacity to respond to the disaster situation.

INGENIOUS is developing:

- **Intelligent Helmet, Uniform, Boots** and **Wearables** for First Responders and **Vests** for K9 Units
- **2 different types of autonomous drones** for indoor and outdoor operations,
- **Multisensory systems** for rapid FR status, environmental mapping and enhanced accuracy in positioning
- **Interfaces** to fuse information and **AR displays** for tactical view and enhanced situational awareness

INGENIOUS Goals

INGENIOUS is providing a high end technology solution to facilitate each step in the disaster-management process during a small or major emergency. The Next Generation Integrated Toolkit for Collaborative response armours the First Responders with all the means:

1. To better gather information from the emergency scene
2. To immediately evaluate the seriousness of the situation
3. To disseminate the information across the First Responders' teams and the public safety agencies
4. To lay a stronger foundation for taking action and devise a common, integrated and coordinated response plan
5. To improve the ability to analyze options and take decisions.

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INGENIOUS Technologies for First Responders

INGENIOUS Smart Helmet

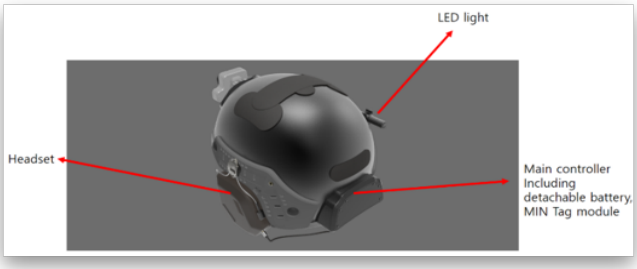
The **Smart Helmet** aims to **improve FR's situational awareness** through electronic modules that can be attached and detached to/from conventional helmets. Electronic modules contain EO/IR cameras, headset, main processing unit and so on.

Main features:
Hands free voice communication, using IR (thermal) camera data for situation awareness

Benefits:
Improved visibility in dark or smoky situations, hands free voice communication

Advances for the First Responders:
Increased situational awareness and work efficiency

Competitive advantages compared to other similar solutions on the market:
Ability to use conventional helmet



Organisation: Korea Institute of Robot & Technology Convergence
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INGENIOUS K9 Vest

The **K9 Vest** aims to increase the operational capacity of the K9 unit, the situational awareness of the K9 handler and of the Strategic Coordinator. Currently, the K9 units operate without any technological equipment, relying heavily on the training of the dog and the collaboration between the dog and the handler. The INGENIOUS K9 Vest will provide situational awareness from the canine's location (GPS), two video streams (HD and thermal) and bidirectional audio.

Click **to watch the video of the K9 Vest**

Main features:
- Low cost equipment with high efficiency
- Light weigh, easy to use and operate

Benefits:
- Smart wearable for K9 units to enhance the operational capabilities

Advances for the First Responders:
-Smart canines in the field providing live feedback from the field (images, video and sound)

Competitive advantages compared to other similar solutions on the market:
- Customizable depending on the rescue mission

Organisation: ICCS
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INGENIOUS Smart Uniform Processing Pack

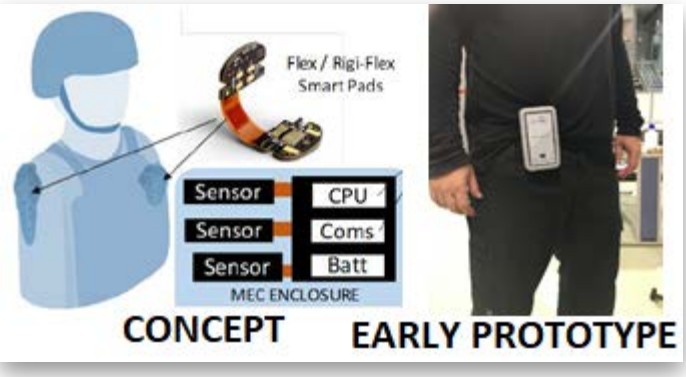
Lightweight and rugged device to be easily attached or integrated into **First Responders uniforms**. Reduced cost solution offering a wearable high-performance multipurpose sensing, processing and comms hardware, suitable for harsh environments and FRs operations. The device is able to link to other sensors and systems of FRs and locally process and aggregate the information to support local operation of the FR as well as communicate remotely.

Main features:

- Rugged but lightweight design, wearable, easy to use and set up, battery operated.
- Custom AI-enabled edge device wit multipurpose integrated capabilities for smart communications and scalable multisource sensor data processing.
- Reliable operation for a whole working day

Benefits:

- Smart information processing locally available for FR. Multisensor information collection and processing
- Non-distracting technology, simple to use and attach with no further interaction requirements



Advances for the First Responders:

- Easy management of different sensors and wearables without need for manual interaction
- Advanced processing and early warning and detection thanks to the ability to locally combine the information from different systems

Competitive advantages compared to other similar solutions on the market:

- Designed to respond to FRs' requirements in a wide set of scenarios.
- Factory compatibility with a series of INGENIOUS Smart FRs tools and services

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INGENIOUS Smart Boots

The **Smart Boot System** is a wearable tool that boosts the INGENIOUS toolkit and enhances operational capacities. The smart boot system is composed of the hardware that is the insole itself located inside the FR regular boots and the Boot Edge Software (BES) hosted by the Uniform. The insoles acquire live data from the build-in Inertial Measurement Unit (IMU) and pressure sensors and using Bluetooth Low Energy 5 connectivity they transmit the raw data in real-time and high frequency to the Uniform. The BES uses intelligent algorithms and generates events based on FR's activity, such as FR is immobilized, hanging, scrolling, lifting weight. The events are redirected to the control center for further actions and analysis. For example, in case of fall or immobilisation detection by the Smart Boots, the team leader or person in charge is notified to act and assist the FR in distress.

Main features:

Smart Insole

- Bluetooth 5 connectivity
- High-frequency data transmission
- Data acquisition from 9-axis IMU and pressure sensors
- Ultra-low power consumption
- Rechargeable battery with wireless charging
- Extensive battery life

Smart Algorithms

- Real-time data processing
- Event generation

Benefits & Advances for the First Responders:

- Informs FR's activity status by generating events (immobilized, hanging, lifting weight, etc)
- Enhances operational capacities, health, and safety
- Improves situational awareness

Competitive advantages compared to other similar solutions on the market:

- Fully wearable and integrated with the INGENIOUS NGIT
- Real-time activity tracking and hazard/fall notifications

Organisation: CyRIC
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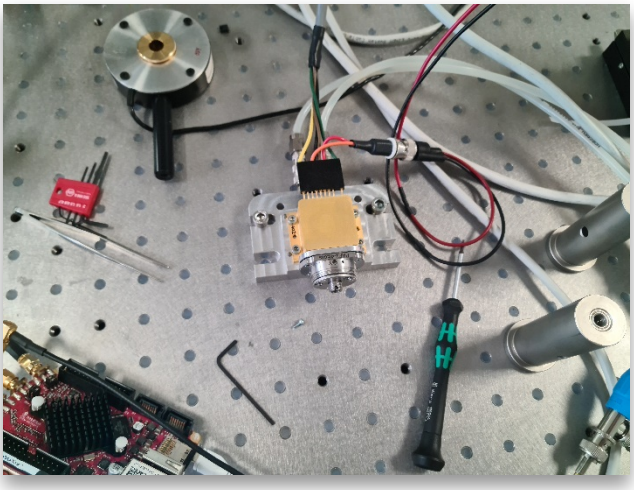
Quantum Cascade Laser for the Gas Sensor

Alpes Lasers SA provides a **Quantum Cascade Laser (QCL)**, which is a crucial component of the gas sensor developed by **TUW**. For each molecule we want to detect, a new QCL need to be designed. Alpes laser is developing «pigtailed» QCLs, where the light is coupled into an optical fibre. Therefore, the user can have a «plug & play» device, and plug the bendable optical fibre to its components. Also, we are developing a solution to combine several wavelengths into one optical fibre, so that one can detect several molecules simultaneously.



Main features:
Important part of a gas sensor

Benefits:
Efficient detection of molecules

Advances for the First Responders:
Detection of molecules' concentration exceeding toxicity thresholds

Competitive advantages compared to other similar solutions on the market:
Higher sensitivity offered by QCLs

Organisations: Alpes Lasers SA & TUW
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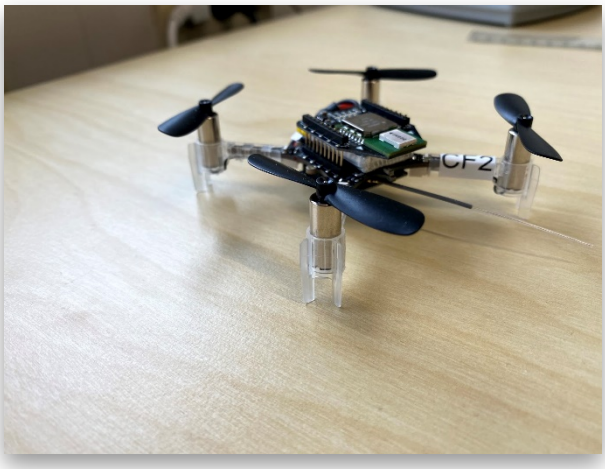
INGENIOUS MINs - Micro Indoor drones

The **MINs - Micro Indoor drones** are micro-indoor drones that support the localisation of first responders (FRs) in semi-collapsed and dangerous buildings. Currently, GPS signal or similar technologies do not work in indoor environments, hence the team working outdoor is not aware of the position of the FRs operating inside the building. The MINs try to address this problem by creating a self-deploying mesh-network of drones to track the movement of FRs while operating indoor.

Click on VIDEO 1 – VIDEO 2 – VIDEO 3 to watch the videos for the MINs



Main features:
Localisation technology for GNSS-denied environments, e.g., indoor and other environments where GPS signal is not available

Benefits:
Safer rescue operations

Advances for the First Responders:
Provision of real-time information about the position of rescuers operating in dangerous indoor environments

Competitive advantages compared to other similar solutions on the market:
Unique, first-of-its-kind solution to the indoor localization of moving targets (people or objects) in GNSS-denied environments

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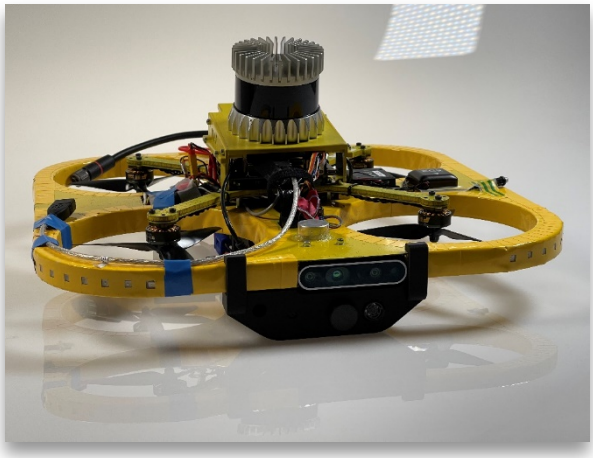
INGENIOUS MAX - Multi-purpose Autonomous eXploring drone

The **MAX - Multi-purpose Autonomous eXploring drone** is an autonomous aerial scout that explores and maps dangerous and complex indoor environments, acquiring a multitude of different sensor data, including visual images, thermal images, 3D data, temperature and gas detections. The drone builds a 3D map of the environment in real-time and navigates autonomously to acquire data from previously unobserved areas.

Main features:
- Systematic assessment of complex environments with several sensors
- Autonomous exploration and navigation



Benefits:
- Efficient and safe use of drones in indoor environments
- Drone not dependent on stable communication with ground control station; solves its task fully autonomously
- Drone control through high-level task commands; manual operation only as exception

Advances for the First Responders:
- Assess buildings without entering them
- Get the advantages of using drones without the need to pilot and monitor them in real-time

Competitive advantages compared to other similar solutions on the market:
- Equipped with several sensors, customizable depending on the task
- Designed to address operational needs and challenges

Organisation: FOI
Contact person: Dr. Gustav Tolt - gustav.tolt@foi.se

INGENIOUS Integrated Positioning System (IPS)

The **Integrated Positioning System (IPS)** calculates the First Responders position in indoor and outdoor environments and also takes inspection images and geo-references them for digital documentation.

Click **to watch the video of the IPS**

Main features:
Calculates the First Responders' position continuously in indoor and outdoor environments, takes inspection images and geo-references them for digital documentation

Benefits:
Enables fast and reliable continuous self-localization of First Responders in combined indoor and outdoor spaces

Advances for the First Responders:
Raises the safety and situational awareness during the operation

Competitive advantages compared to other similar solutions on the market:
There are no comparable solutions on the market available

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INGENIOUS Modular Aerial Camera System - Search and Rescue (MACS-SaR) providing Large Scale Operational Picture (LSOP)

The **Modular Aerial Camera System - Search and Rescue (MACS-SaR)** consists of a VTOL drone and a special camera system that generates and provides a map of a region of interest and its surrounding for fast disaster assessment.

Click **to watch the video of the MACS-SaR**

Main features:
Large scale situational picture (LSOP)

Benefits:
Fast disaster assessment at large scale

Advances for the First Responders:
Basis for relief mission planning

Competitive advantages compared to other similar solutions on the market:
All-in-one (only one tool necessary)

Organisation: DLR
Contact person: Dr. Henry Meißner - henry.meissner@dlr.de

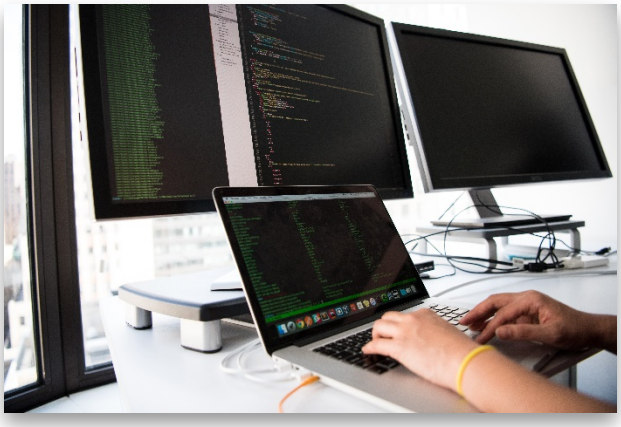
INGENIOUS Situational Awareness Algorithm

Unmanned Aerial Vehicles (UAVs) are very valuable equipment in emergency rescue. When we introduce advanced image analysis methods, the sequential images collected by a UAV's onboard camera can produce more meaningful information for the First Responders. The proposed **AI-triggered situational awareness algorithm** aims at understanding the environment using visual clues and detecting pre-defined objects such as windows, doors, and trapped people. The algorithm can be highly integrated with UAVs to provide a more effective exploration function.

Main features:
The algorithm uses images collected by UAVs as input, detects specific objects and marks their positions in the images

Benefits:
The algorithm automatically extracts high-level semantic information from the collected image sequences without the intervention of the First Responders

Advances for the First Responders:
The UAV integrated with this algorithm enables FRs to know the situation of the rescue site in advance without need of human supervision, thus improving their situational awareness and work efficiency



Competitive advantages compared to other similar solutions on the market:
There are no algorithms on the market for specific emergency scenarios

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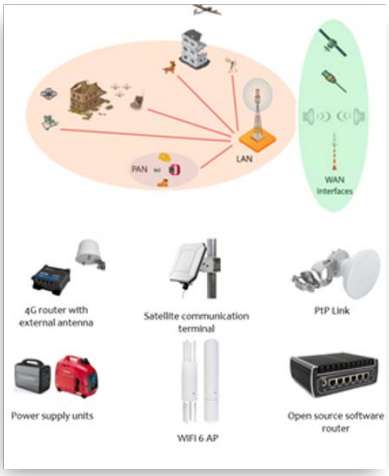
INGENIOUS Field communications

The **Field communications system** consist of multiple technologies, each targeting a specific type of network size (PAN, LAN, WAN), along with a communication gateway that will integrate multiple network interfaces into a single routing node. This network architecture will be complemented with network management service that will be leveraged to provide information for the connectivity status of the end nodes and in this way provide real time connection loss events.



Main features:
The field communications system is intended for providing a proprietary communication infrastructure to be deployed by the FRs in order to get access to a resilient network tailored to their needs

Benefits:
- Portable system
- Deployable in any field conditions

Advances for the First Responders:
Proprietary communication network to connect equipment when common networks fail due to disaster or overload

Competitive advantages compared to other similar solutions on the market:
Multiple communication technologies integrated in a system, easy to use

Organisation: ICCS
Contact person: Dr. Angelos Amditis - a.amditis@iccs.gr

INGENIOUS Fusion Engine (FE)

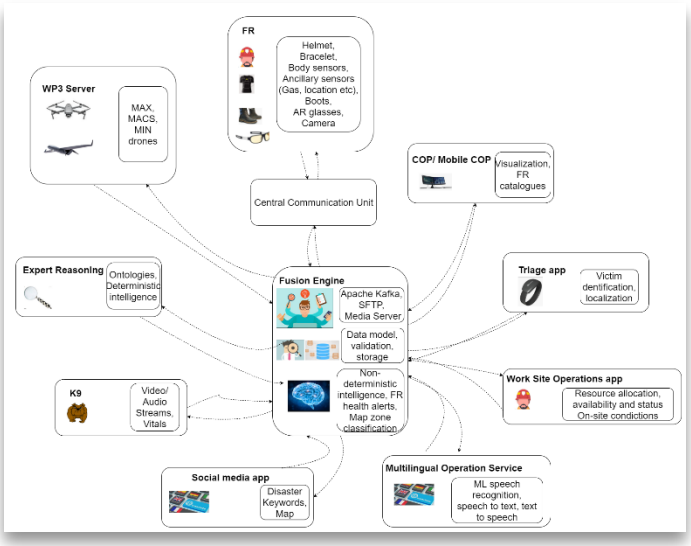
Fusion Engine aims to the integration of multiple sources through its infrastructure and to utilize the data gathered for the extraction of conclusions providing real-time situational awareness and decision support functionalities to crisis operators.

Main features:
- Facilitate the integration of most of the components when there is data exchange between them
- Measurements received from sensors and apps (boots, social media app), validated, transformed and stored appropriately
- Periodical message on FR and their equipment status produced by FE and send to the interested components (COP-ARRP)

Benefits:
Allows the integration of information from many different sources for decision support

Advances for the First Responders:
Allows for decision making and information integration to give a holistic and overall view of the current operational status.
Provides information for the safety of FR such as alerts regarding their health status and possible dangers in the surrounding areas

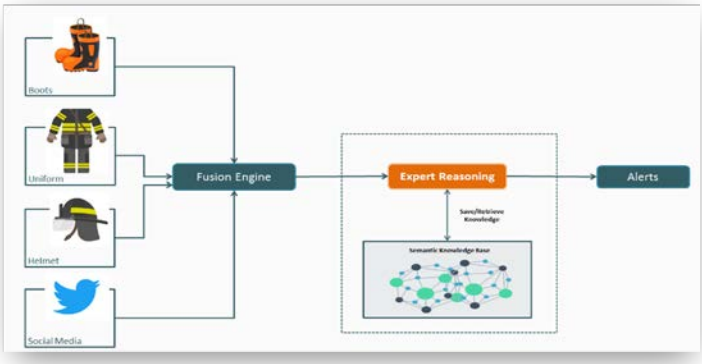
Competitive advantages compared to other similar solutions on the market:
Designed to address operational needs and challenges



Organisation: EXUS
Contact person: Alexia Zoumpoulaki (Ms.) - a.zoumpoulaki@exus.co.uk
Eva Jaho (Ms.) - e.jaho@exus.co.uk

INGENIOUS Expert Reasoning

The **Expert Reasoning system** is responsible for modelling requirements and patterns for capturing information about resources, entities and relationships relevant to INGENIOUS's application domain in order to support the decision-making process and early warnings generation of the First Responders. Concretely, this module is a back-end service that gathers information through the fusion engine from different kinds of IoT systems such as Uniform, and Boots, saves this information to a Knowledge Base (KB), and applies reasoning rules upon this information for inferring useful knowledge for the First Responders (i.e. high heart rate is a reasoning rule which raises an alert). By adopting the technology of ontologies, we can uncover new information out of the existing relations; hence more complex rules can be applied by combining information of different resources (i.e. boots with uniform combination) leading to a wider variety of useful alerts.



Main features:
- Process/combine all the vital sensors of the First Responder
- Processing inputs from Social Media App and raise spatio-temporal alarms
- Raise alarms for First Responder in danger
- Provide precise, relevant, accurate and reliable information

Benefits:
Provide a trust level alarms based on the sensors sensitivity. Also, alerts extract useful spatio-temporal knowledge for the First Responders

Advances for the First Responders:
The alerts extract useful knowledge for the First Responders (i.e. if they reach vital signs limits (heart rate limits)

Competitive advantages compared to other similar solutions on the market:
Integrates CERTH experience in crisis management solutions

Organisation: CERTH
Contact person: Thomas Papadimos (Mr.) - papadimos@iti.gr
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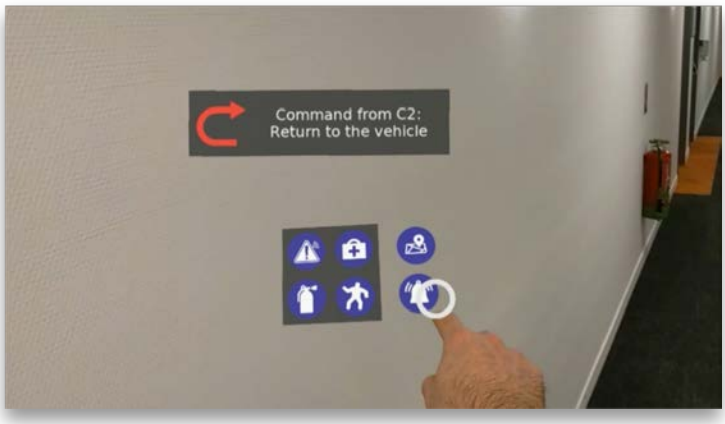
Dr. Anastasios Karakostas - akarakos@iti.gr

INGENIOUS ARRP - Augmented Reality Response Platform

The **ARRP** aims to offer more efficient situational awareness and support to practitioners in critical conditions that require full attention and focus. It delivers real time information gathered from the other components (e.g. team status and location, notifications, location of victims), filtering the information and providing targeted content to the AR user. It also provides first responders with the capability to easily report the geo position of victims or hazard from the field. AR will be supplied through AR glasses and will enable first responders to access previously unreachable information in a contextual fashion, by superimposing the data to the real world.

Click **to watch the video of the ARRP**



Main features:
Direct visual notifications to the FRs, sharing of geo-localised information

Benefits:
Hand-free operation

Advances for the First Responders:
Access to real-time information about their position and nearby risks and points of interest

Competitive advantages compared to other similar solutions on the market:
Strong link with customer segments already using the tool suite for the collaborative conduct of operations

Organisation: CS GROUP
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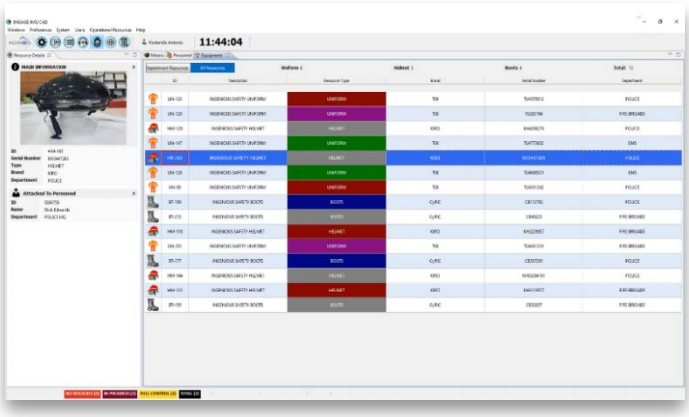
INGENIOUS COP/C3 - Common Operational Picture and Command, Control and Coordination System

The **COP/C3** is based on the ENGAGE, a C3 System provided by Satways Ltd and used by public and private safety organisations. It integrates information from multiple and diverse systems into a single command environment and coordinates emergency response actions based on real-time data. ENGAGE's unified management approach provides visualization of the common operational picture and tackles the complete lifecycle of the emergency situations (incident announcement, response, resolution and recovery). The ENGAGE C3 system is expandable and modular, able to fulfil different agencies' operations, from the field of health protection to the physical infrastructure domain. ENGAGE is available on Desktop and Mobile versions in order to be used by both the Command Center Operators and the First Responders in the field, enhancing the coordinative response and depicting the operational picture at all levels of command and decision making.

Click **to watch the video of the COP/C3**



Main features:

- The **Common Operational Picture** is enhanced by receiving various data (Sensor data, Fused Data and Expert Reasoning Engine Data) and by combining them with operational information. The COP is used as a visual interface to enter data or commands and to control simulation and decision support tools.
- Interoperability Standards are supported.
- The tool provides a **unified User Interface**, so there is no need to switch between different applications (GIS, IMS/CAD, resource management). The User Interface is updated instantly with actions made from other users.
- The tool also provides the ability to **manage the agency's resources**, to track resources on the map, and to share resources with collaborative agencies.
- With a 3D geographical Information System, **Tracking and Visualisation of First Responder positions** is allowed, as well as information /alerts produced by Ingenious Services

Benefits:

One unified User Interface providing: i) the Common Operational Picture, ii) the ability to manage the agency's resources and track them on the map iii) the ability to track and visualize FRs position, iv) the ability to communicate with other agencies and exchange operational information

Advances for the First Responders:

Provides a complete view of the field situation and supports operational procedures. Enables live collaboration with Public safety agencies and exchange of operational information. Therefore, allows for a synchronized response to any incident

Competitive advantages compared to other similar solutions on the market:

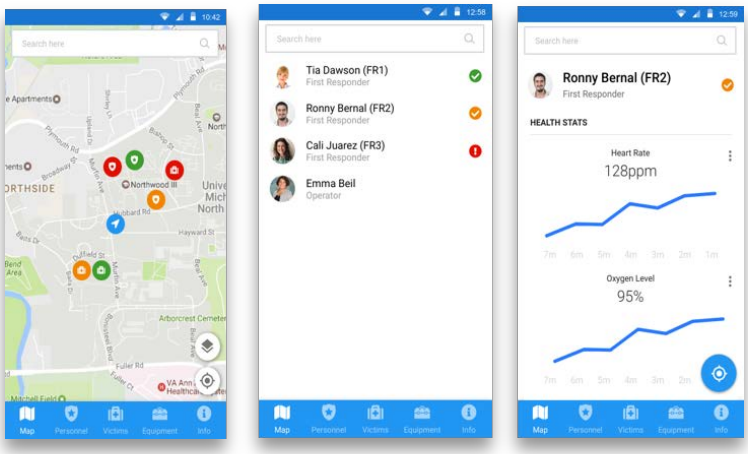
- Advanced Common Operational Picture using information from multiple sensors at the field, combining info from wearable devices (both for FRs and K9) and sensors from UAV
- Tracking, assignment and management of FRs according to the data received in real time for their vital signs
- Ability to communicate with other agencies and exchange operational information, thus allowing for a synchronized response to any incident.

Organisation: SATWAYS
Business Relations: info@satways.net

INGENIOUS Worksite Operations App (WOA)

The **Worksite Operations app (WOA)** aims to aid the resource management and casualty management in the worksite. It fills gaps in search and rescue operations identified by INSARAG and work synergistically with existing tools for day to day management of the operation. The app supports the ability to query the location and status of each FR from the FE and depict it for decision support and better coordination. Status of each FR will indicate health stats, history of activity and equipment allocation. It will also provide an overview of the victim identification procedures. The app could query the triage and face recognition applications for information on victims identified so far. Based on received data, it could create and depict stats by classifying, filtering and presenting data based on the operator's input to increase their situational awareness.

Main features:
- Connects with the FE and online sources to receive data
- Displays information about the equipment and its utilization
- Displays information about the health status of FRs
- Displays information about the weather
- User friendly design
- Provides infrastructure awareness



Benefits:
The operator has access to crucial on-site conditions that may affect prioritizing operational actions

Advances for the First Responders:
- First responder team leader has a better overview of the team and equipment and conditions on site.
- First responder team leader has better overview of victim identification procedures

Competitive advantages compared to other similar solutions on the market:
Unique app incorporating information about first responders' status, on site conditions and victims information

Organisation: EXUS
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INGENIOUS Victim Triaging

The **Triage system** consists of three main parts. A wearable device that presents in visual way the emergency status of the victim and provide identification of the victims, a mobile application that controls the wearable device and can collect information about the victim and a platform that can collect the victim's information.

Main features:
Provides quick, easy, and cost-efficient way to immediately report and identify injuries

Benefits:
Easy standalone application deployable in any mobile device

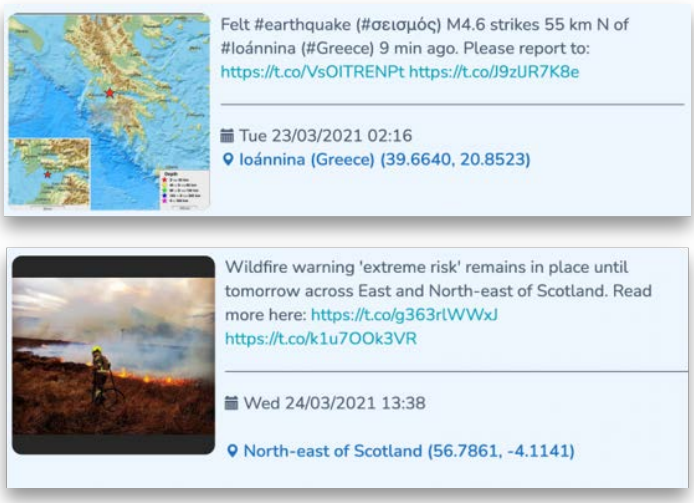
Advances for the First Responders:
Led light for easy identification of the status of the injured

Competitive advantages compared to other similar solutions on the market:
- Target to cost the hardware less than 10$ per unit
- Reusable in multiple cases
- Complete solution to track and provide help to injured
- Support API communication and can be combined with other Apps

Organisation: ICCS
Contact person: Dr. Angelos Amditis - a.amditis@iccs.gr

INGENIOUS Social Media Application

CERTH's **Social Media App** is able to timely collect tweets about crisis events around the world and automatically geotag them based on locations mentioned in their text. Is an online module that uses criteria specified by the user to fetch tweets. The collected tweets are public and the open Twitter API is used, ensuring how operational costs. Fake and irrelevant tweets are filtered out.



Main features of the Social Media App:
- Any locations mentioned in the tweets are detected
- Fake and irrelevant tweets are filtered out

Benefits:
Through this module, social media data can serve as a valuable source of information for practitioners in crisis management, additional to their traditional means.

Advances for the First Responders:
Emergency first responders do not have enough time to discover and evaluate social media posts with useful information, as this would take valuable manpower away from more important tasks. Thus, the Social Media App collects and filters the relevant information for them automatically.

Competitive advantages compared to other similar solutions on the market:
AI-enhanced technologies for automatic geotagging and classification of posts as relevant/irrelevant and true/fake.

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INGENIOUS Multilingual Operations Application (MOA)

The **Multiligual Operations App (MOA)** is a Speech-to-Speech translation that provides communication support, within INGENIOUS, to ease the communication between teams of FRs from different countries. The objective of the MOA is to facilitate the communication between international teams, avoiding communication misunderstandings, like the ones that can be caused by emergency codes while keeping the communication safe and fluent as needed in an emergency situation. The MOA is integrated into the system, and adapts the language model to the FR domain. It is integrated as a telegram bot, making it easy to install in any smartphone.

Click **to watch the video of the MOA**

Main features of the MOA:
- Includes Spanish, French, Swedish, German and English.
- Allows multilingual communication between FR from different countries
- The language models incorporate the FR specific terms and expand the emergency codes
- Includes geographic names of the emergency area

Benefits:
Easy to implement as it runs on smartphones.
Tailored to FR domain

Advances for the First Responders:
When different teams of First Responders from different countries must collaborate, each team has its own communication channel (often radio channels) with different technologies. The MOA uses smartphones, to simplify the communication between teams, allowing a multilingual communication channel that will automatically translate speech and expand to natural language the emergency codes contained on it.

Competitive advantages compared to other similar solutions on the market:
There are solutions that do Speech-to-Speech translation but:
- They are not (and cannot be) tuned for the emergencies domain, so, they can introduce errors and misunderstandings.
- They are not integrated and do not create a channel that knows who has the rights to use it and manage the language of each user.

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INGENIOUS

Enhancing Situational Awareness, Safety and Collaboration for the First Responder of the future

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