IOPES

Indoor-Outdoor Positioning
for Emergency Staff

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D5.4: Field test report 2

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Contributors	M. Eulàlia Parés, Pedro Espín, Daniele Munaretto, Jordi Salvador, Florian Olrich, Guðbrandur Örn Arnarson
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List of acronyms

CPET	Civil Protection Emergency Teams
EMS	Emergency Management System
GIS	Geographic Information Systems
LTE	Long Term Evolution
RPAS	Remotely Piloted Aircraft System
UAV	Unnamed Aerial Vehicles
Project partners	
ATH	ATHONET SRL
CATUAV	CATUAV SL
CTTC	Catalan Tecnological Telecommunications Centre
FBBR	Frederiskborg Fire and Rescue Service
PCF	Pau Costa Foundation
SAReye	SAReye EHF
SCARABOT	Scarabot Technologies GmbH

1. Executive summary

The functional exercise 2 aims to test and to validate the whole IOPES prototype B in a simulated, not hazardous scenario. The exercise took place in TCRH Mosbach (Germany). In this report we present the performance of the IOPES prototype B and we assess the degree of compliance provided by the IOPES system with the CPE needs in an emergency scenario; identify IOPES prototype B limitations and features to be improved in a new release of the system.

2. IOPES concept in brief

The IOPES project aims to increase the safety and efficiency of the CPETs (Civil Protection Emergency Teams) in the course of emergency operations resulting from human-made and natural disasters. To achieve that, the project develops and enhances operationally oriented technologies that are targeted to provide precise and detailed information about a hazardous environment that can drastically change where it becomes paramount to safeguard the lives and the physical integrity of the operatives in the field.

The IOPES technology relies on four pillars:

- RPAS-based fast mapping tool.
- Wearable positioning device.
- LTE/ 5G deployable communications.
- Mature EMS (Emergency Management System).

The combined use of these technologies will assist in better tracking the positions of the members of emergency teams, both in indoor and outdoor environments, which could help improve the CPETs situational awareness and facilitate their decision making during disaster-related operations.

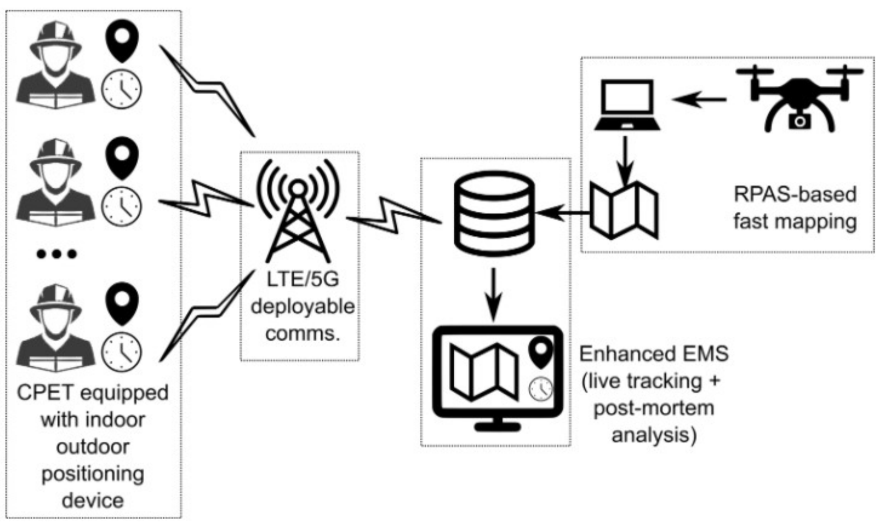


Figure 2-1. IOPES concept.

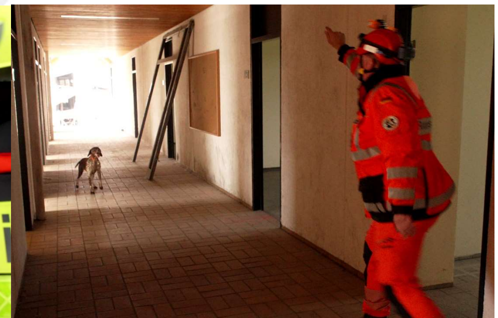
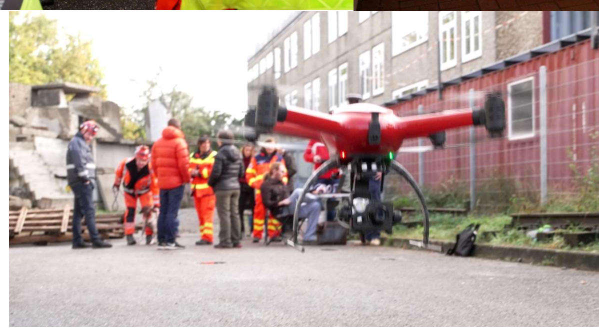
3. Objectives

The aim of the IOPES functional exercises is to test and validate the innovative technologies developed in the project in a simulated environment under controlled (not hazardous) conditions. Specific objectives are:

- Design realistic and dynamic emergency scenarios consisting of compromised situations where Search and Rescue operation are required.
- Deploy these scenarios in a small-scale field test involving the participation of end-user organisations.
- Showcase how the IOPES technology can be used in real emergency situations and the value it can provide to the end-users.
- Gather feedback (i.e., opinion and evaluation) from end-user organisations invited in order to identify current strengths and limitations leading to further refinement of the technology.

4. Exercise 2

The second small-scale exercise took place at the TCRH premises in Mosbach during the October 11th and 13th 2021. The exercises were done as described in [1] by 5 volunteers of Deutsche Rettungshundeverein e. V. (DRV) with 9 dogs and by Mr. Jesper Marcussen (Strategy & Coordination) of Frederiksborg Fire & Rescue Service (FBBR).

Images of the exercise can be seen in the final video of the IOPES project, freely available at https://www.youtube.com/watch?v=sjBLCg7Lxdc

5. Exercise evaluation

5.1. System performance

In the following table, the summary of the IOPES version B system performance, according to the indicators presented in the IOPES proposal, is showed.

Outcome	Output	Indicator	Baseline value	Target value	Actual value	Monitoring strategy
an IT-based solution to facilitate response	Wearable positioning device & data exchange protocol	Outdoor/Indoor Positioning performance	0.5 – 2 m outdoors 10 m indoors	0.5 – 2 m outdoors 5 m indoors	2 m outdoors 3 m indoors	Field testing
		Temporal resolution	1 position every 20s	1 position every 5s	1 position every 1 s	Field testing
		Operational time	4 hours	8 hours	>8 hours (using 2 batteries)	Field testing
		Cost	600€	300€	512€	Architecture document
	LTE/ 5G deployable communications (small manpack)	Number of communicated users (voice + data)	20	200	20 tested. 200 simulated.	Unit testing
		Coverage	< 1km	< 1km	Tested with 500-700 m	Field testing
		Network latency	100 millisecond	50 millisecond	< 50 millisecond	Field testing
	Enhanced EMS	Visualisation and management of simultaneously tracked users	50	100	Tested with 2 in the exercise, With 50 oit of exercise	Unit testing
		Historical of team members positions (minutes)	10 minutes	30 minutes	Days	Unit testing
	Mapping	Spatial resolution	10 cm	5 cm	2.5 cm	Field testing
		Required time to generate the cartography	Time per hectare	Time per hectare	15 minutes low resolution	Field testing

a system to collect /analyse response data for developing evidence-based response strategies	Enhanced EMS + LTE/ 5G deployable communications	Number of stored conversations and positions for post mortem analysis	5	10	>10	Field testing

5.2. Degree of compliance with CPE needs

Emergency services attending the functional exercises, both as participants and observers, has been asked to provide their feedback to evaluate the usefulness of the IOPES technology and propose improvements [3].

The advantage of having emergency services attending the functional exercise lies in the fact that they are potential end-users of the IOPES technology.

5.2.1. Evaluation objectives

The main points of the evaluation are:

- *Validation of the IOPES technological components based on their use in emergency management scenarios. I.e., What went well and what went wrong in using these technologies in a small-scale field exercise?*
- Regarding the Helmet subcomponent. It proves to be useful and to provide location with <5m precision. In the three scenarios it provides continuous and reliable solution. However, at some points there are problems with the communication component of the helmet. If the signal is lost, then the system is not able to do the re-call. The location is still depending on the magnetometer system and it can fail in future trials.

  Regarding the UAVs component. The fast-mapping system works perfectly and proves to be a useful tool for emergency analysis scenario. Regarding the UAV as RT system for emergency tracking, some faults occur with the drone radio system, and we were not able to see all the potential of the system.

  Regarding the deployable LTE system, it is proved to be very useful in urban and rural scenarios where no national mobile operator connectivity is available. We noted that, due to an old defected cable of the power supply unit, one of the daily exercises could not take place as it affected the power-on procedure of the hardware components. The feedback was communicated to the 3rd party provider of such cable in order to avoid further failures of the unit. The issue is anyway limited as it affects only old versions of the manpack now used for demos, not for commercial purposes.

  Regarding the EMS, it proves to be useful and to have all the needed information for tracking staff in real time and in post-processing. The system performance is quite dependent on internet connection quality. This can be improved by installing the system on a computer ad-hoc

- *Evaluation of the adaptability of the technology/implementation to any type of emergency situations. I.e., Can these technologies be used in any kind of emergency situations resulting from human-made and natural hazards? If not, please name which ones.*

  We tested the system in:

  - Earthquake situation with a lot of collapsed infrastructures. Big concrete walls collapsed and building without light and difficult access.

  We see some problems in very narrow spaces that can be solved by improving the ergonomy of the helmet. In dark conditions the system works properly and provides useful information on height and on location.

- *Evaluation of the technology transfer to emergency services. I.e., Can these technologies be easily employed by your organisation to improve situational awareness and support decision making processes?*

  According to the conversations with the end user's that came to the exercise. It would be quite easy and direct to transfer each tested technology by their own. As a hole, it could be more complicated because some of those technologies, mainly EMS are already implemented in the emergency services. Regarding the rest of technologies, since their interact though very easy interfaces, can be transferred quite easily.

- *Advantages and limitations in the functionalities. What are the advantages and limitations of the functionalities of these technologies?*

  Knowing the situation of the staff seamless if it is indoor or outdoor is the main advantage of the solution. The main problem with the technology used is that do not work in foggy or smoky environment.

  The main problem with UAVs is that they have some limitations also in foggy, dark or smoky environment. Otherwise, they provide almost real time (15 minutes from launching) perfect image of the situation.

  The main advantage of deployable communications is that the team do not depend on external communication providers. No cons were detected besides the defected cable as pointed out above.

  EMS systems are widely used in the context of emergency and our test field do not add nothing new to the previous knowledge.

- *Compatibility with existing tools. Are these technologies compatible in use with other exiting tools currently available and well-established at your organisation?*

  The helmet transmits the position through classical LTE/5G system and with a pre-defined API. It is very easy to integrate in any visualization or database system.

  Regarding the UAVs, the images can be generated in any image format, also allowing to be easily uploaded to any emergency system.

The 4-5G communications system is fully autonomous in terms of batteries and mobile connectivity (local private mobile network) and can be interconnected to other communications means such as TETRA-PMR, or to other mobile networks via backhaul links such as satellite, 4-5G, microwave, fibre.

5.2.2. End-Users' feedback

The evaluation of end-users has been compiled by means of a dedicated questionnaire. One questionnaire will be designed for both functional exercises, however the questionnaire for the second exercise might be refined based on the results obtained from the first one.

The end-user's evaluation form addressed each of the IOPES technologies:

- RPAS-based fast mapping tool

  The whole of the participants found it very useful, only limitation is that in case of flying over smoky areas occlusions may occur. They believe it can help a lot in emergency management and planning.

- RT vision with RPAS

  The hole of the participants found it very useful, but in case of flying over smoky areas. They believe it can help a lot in emergency management and planning.

- Wearable positioning device

  Most of the attendants declared themselves impressed. They asked for improvements on ergonomics, since every emergency scenario and every emergency team have different limitations. They stated that if the system arrives to the market, it could be very valuable.

  Some different configurations for the device (e.g. moving some parts, such as the processor and the battery, to the rescue team vest) were discussed. Also its chance to be adapted for dogs teams.

- LTE/ 5G deployable communications

  They all declared interest in the system. Since this is already a commercial system, they asked for more information because it provides autonomy and enhanced bandwidth. They are also interested in hosting demos and training at their facilities to get familiar with such new technology.

- Mature EMS (Emergency Management System)

  They like the system but declared that they are using their own system and they are not going to change. Improving the own systems with a tracking module seems a very realistic and interesting solution.

6. Reference documents

[1] IOPES (2021). *D5.2 Scrip for field tests in ES, DE*.

[2] IOPES (2021). *D3.1 User requirements report*.

[3] IOPES (2021). *D5.1 CPE exercises operations plan_V2.*

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