Interoperability of Solutions in a Crisis Management Environment Showcased in Trial-Austria

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Abstract.
Crisis Management (CM) is a challenging area when it comes to connecting solutions aiming to support the various tasks involved in handling of CM situations. DRIVER+ [1] an EU-funded project launched in 2014 was setting up a technical infrastructure (so called Test-bed) that allows to interconnect solutions, so they can interact and exchange all crisis relevant information that commanders need, to make their decisions and plan their actions related to a specific crisis.
To verify the DRIVER+ Test-bed as well as the DRIVER+ Trial Guidance Methodology [3] and furthermore, to overcome identified CM gaps [2], a series of Trials was setup. Trial-Austria was the fourth one to be executed.
This Trial was especially challenging as it was held as a field exercise in parallel to a huge European Civil Protection Exercise (called IRONORE2019). The scenario to be dealt with was an earthquake scenario.
The developed methodology, Test-bed as well as various solutions taking part in DRIVER+ are a perfect base and platform to deal with whatever hazard (e.g. chemical, physical, etc.) is endangering our environment or wellbeing.

Keywords: Crisis Management, DRIVER+, Trial, earthquake, interoperability, innovative solutions, environmental hazards

1 Introduction / Trial / Scenario

1.1 Introduction

The scale and pace of crises pose enormous challenges to the Crisis Management (CM) sector, with new threats emerging all the time. An already complex field must also strive to integrate new technologies and methods, cope with a rapidly changing infrastructure, understand evolving risks, be effective across cultural, administrative and national boundaries and engage with populations to enhance their resilience. Innovation is therefore critical but will only be successful if it is relevant and accessible to practitioners and operators. Many crises involve interfacing diverse CM systems and solutions. Major crises can also frequently involve more than one country or region, which may have differing CM infrastructures and cultures. It is also highly likely that this will

necessitate interfacing different systems and combining different solutions. CM innovation must therefore be capable of meeting these multifaceted challenges and delivering solutions that are modular, flexible adaptable and interoperable.

The DRIVER+ Project [1] is dealing exactly with such challenges and within the project's run period (2014-2020) so-called Trials were launched, testing various technical and non-technical solutions.

Furthermore, DRIVER+ seeks to improve the way capability development and innovation management are tackled, by testing and evaluating solutions that address the operational needs of practitioners dealing with Crisis Management (CM).

Understanding the main problems that CM practitioners are currently facing is important to ensure that the project's results correspond to the practitioner's needs.

Thus, DRIVER+ drew up a list of 21 gaps [2] organized in five CM functional domains: decision support; information sharing and coordination; engaging the population; resource planning and logistics, as well as casualty management.

Four Trials (held in Poland, France, Netherlands and Austria) were set up and conducted during the project, which focused on these gaps, by identifying the differences between the current capability and the capability deemed necessary for an adequate performance of one or more crisis management tasks.

2 Trial Guidance Methodology

The Trial Guidance Methodology (TGM) [3, 4] is designed for Crisis Management practitioners as it facilitates a robust assessment of innovative solutions. The TGM provides step-by-step guidelines on how to assess them in non-operational contexts (such as a Trial) through a structured approach.

The methodology consists of three phases: preparation, execution and evaluation. The preparation phase results in a Trial design with multiple elements that are captured within a Trial Action Plan document, whose main outcome is meant to be applied and executed in the second phase. The Trial committee is responsible to ensure that all decisions taken in the first phase can be executed.

Each Trial consists of three elements: the tailoring of the Test-bed in accordance with the Trial design, the finalization and simulation of the identified scenario within the Test-bed, and the ability to carry out an assessment of the three DRIVER+ performance measurement dimensions (i.e. CM-, Trial-, solution dimension).

The execution phase ends with the running of the actual Trial, through the simulation of the pre-defined scenario, the deployment of potential innovative solutions and the collection of relevant data. In addition to the data collected during the Trial, additional feedback from external stakeholders (participating actively as Trial actors or passively as observers) is gathered after the main event.

During the third phase, the gathered data is processed in order to assess and analyse the real impact of the innovative solutions. This information is not only very useful for the CM practitioners but is also valuable for the solution providers concerned with further improvement of their solutions.

DRIVER+ has developed and issued a Trial Guidance Methodology Handbook providing an overview of what crisis managers would need to do in order to depict a specific operation and integrate new socio-technical solutions in their ways of working. The Handbook can be downloaded from [3]. It offers not only a guidance on what to do by whom and when, but also introduce appropriate tools and methods to conduct those tasks. It also provides information about the DRIVER+ Test-bed technical infrastructure.

2.1 Test-bed

The main purpose of the DRIVER+ technical infrastructure [5, 6] simply called Test-bed is to facilitate preparing, executing and evaluating a Trial. The Test-bed provides a toolkit to connect innovative CM solutions to each other and to integrate legacy systems to enable an exchange of information between them. That means it provides software components to:

- Connect solutions for data and information exchange
- Connect Simulators to create a fictitious, but realistic, crisis
- Create and control the scenario's storylines
- Record and collect observations and logs

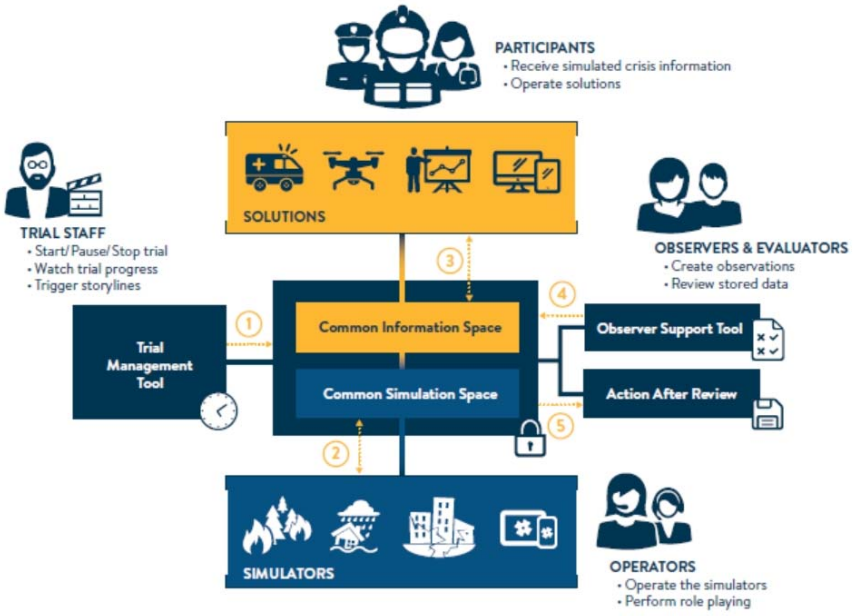

Fig. 1. DRIVER+ Test-bed technical infrastructure [5, 6]

Fig. 1 presents the flow of information and interactions between the actors on the one hand and the involved solutions and tools on the other hand.

The flow as indicated in the **Fig. 1** is as following:

1. The Trial starts: storylines are activated, and the fictitious crisis evolves.
2. Simulators process storylines and additional operator actions. Simulator data is sent to the solutions.
3. Solutions are fed with simulator data, they share information, and request actions from the Simulators.
4. Observers create observations, which are shared and recorded in the Test-bed.
5. The Trial ends and all logs and observations are collected for evaluation.

The connected components as shown in **Fig. 1** are:

- SOLUTIONS: The solutions are assessed during the Trial. They can be connected to the Test-bed via CIS adapters such that they can send and receive data from other solutions and simulators.
- Common Information Space (CIS): Set of KAFKA topics [7] to exchange data between solutions, to receive data from and send commands to simulators.
- SIMULATORS: Provide a fictitious crisis during the Trial for participants and solutions, so solutions can be evaluated effectively in a realistic setting and such that participants feel immersed in the simulated crisis. They offer data and visualizations, such as 3D virtual reality views, flooding plots, fire progressions, panicking crowds and jammed traffic, simulated (social) media messages or a regional/national set of available resources.
- Common Simulation Space (CSS): Set of KAFKA topics to exchange information between simulators, so they are synchronized and can act as one. Simulators send, via a gateway to the Common Information Space, data to solutions and receive instructions to be executed.
- Trial Management Tool: Acts as composer and conductor, offering the Trial staff control over the Trial. During preparation, the staff can create storylines and acts, which represent possible evolutions of the simulated crisis. During the Trial itself, the staff can start and pause the Trial, its storylines and acts, thereby influencing the direction of the Trial and the challenges that the participants face.
- Observer Support Tool: Runs on tablets and in browsers, to create observations quickly that are targeted at specific moments in time during the Trial.
- After Action Review: Facilitates a detailed, data-based evaluation after the Trial. Stores all messages and observations exchanged during the Trial execution, as well as screenshots from running applications, so it can be reviewed together.

The added value of the Test-bed is that it supports not only the interoperability of solutions but also enhances the quality and realism of trainings and exercises, supports in the evaluation of all actions played/executed during the Trial and is available as open source and free of charge.

To deploy, configure and run the Test-bed technical infrastructure anytime and anywhere, and to simplify connecting solutions and simulators, these extra components (see **Fig. 2**) are available to software developers and system administrators.

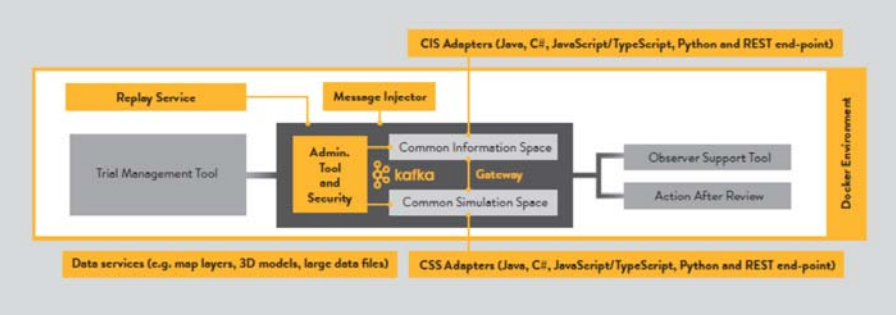

Fig. 2. DRIVER+ Test-bed software for developers and system administrators

- Docker environment: Part of the DRIVER+ website on which you can select the Test-bed components to be installed. It creates one installer containing the Docker images of all the selected components, such that these can be easily installed in one go.
- Replay Service: Developer component to send out a set of pre-recorded messages across one or more KAFKA topics. Can also be used to demonstrate solutions in a realistic context.
- Administrator Tool and security: Developer component to set-up and manage the KAFKA topics and security needed in the CIS and CSS for a specific Trial.
- Message Injector: Developer component to quickly send out a message on one KAFKA topic.
- Gateway: Translates messages from CSS to CIS and vice versa. CIS messages are standardized for use in emergency services communications. CSS messages are optimized for massive throughput and quick handling by simulators.
- Data Services: A set of complementary services to support the Trial, e.g. for storing large data sets, a height model, data from a flooding simulator, a set of fictitious resources, points of interest, map layers, etc.

A detailed description of the Test-bed can be found at [8].

3 Benefits of carrying out Trials

The objective of a Trial is to assess and evaluate solutions in a realistic CM environment by providing a technical infrastructure for them to connect to each other and to provide a possibility for improvements by getting feedback from practitioners using the systems, applications or apps.

The DRIVER+ approach takes as a starting point the fact that there is a strong innovation momentum present in the Crisis Management community. At the same time,

there is inertia to change, which can prevent this momentum from resulting in sustainable improvement. This points to the need for a better evidence base for Crisis Management capability investment decisions.

Innovation is critical but will only be successful if it is relevant and accessible to practitioners and operators. This is exactly what the Trial is aiming for, namely to test innovative solutions under simulated crisis conditions, by gradually adapting them to operational constraints, as well as creating acceptance among users through their active involvement and by providing evidence to decision makers that they are cost-effective.

3.1 Trial-Austria

In a nutshell: Trial-Austria focused on a severe earthquake and subsequent heavy rains simulated in the central area of Austria, causing extensive damage in the most affected area, the local region of Eisenerz (in Styria, Austria).

The main objective of Trial-Austria was to find solutions that overcome shortcomings and limitations [2] in the management and monitoring of spontaneous as well as affiliated volunteers on the crisis scene in terms of location, tasking, capabilities and duration of operations. It was also to highlight the ability to merge and synthesize disparate data sources and models in real time (e.g. visualization of resources, critical assets map, damaged objects/ infrastructure etc.) to support incident commander decision making, situation assessment and exchanging crisis-related information.

The Trial also focused on (non-technical) solutions for providing psychological first aid and support as well as interaction with population (e.g. foster communication capabilities, registration of affected people, provide safety information, etc.).

Trial-Austria was organized by AIT Austrian Institute of Technology and hosted by the Austrian Red Cross in the centre of Austria at Eisenerz/Münichtal from Thursday 12th to Saturday 14th September 2019. The Trial was conducted as a multi-day field exercise run in parallel to the large-scale European Civil Protection exercise called IRONORE2019 [9].

3.2 Solutions in the Trial

3.2.1 CrowdTasker

CrowdTasker is a solution (from AIT Austrian Institute of Technology) for citizen involvement and community interaction. It supports informing citizens, eliciting contributions to the common operational picture by pre-registered parties and integrating efforts of self-organization. This is achieved by issuing assignments and situational information to a selected group of citizens based on their location and skill set, as well as offering a chatbot interface for emergent groups to participate using their own organizational infrastructure (such as social media groups).

The objective of CrowdTasker is to improve informed decision-making of both crisis managers and citizens. It enables professionals to rapidly query information from users at relevant locations and to provide meaningful assignments to citizens during preparation, mitigation and response. CrowdTasker helps to include several forms of volunteering [10, 11,17] into the overall relief efforts [18]: spontaneous contributions of individual citizens, requests for contribution that originate from the crisis manager and are then executed by volunteers or even the integration of existing groups for guidance and support.

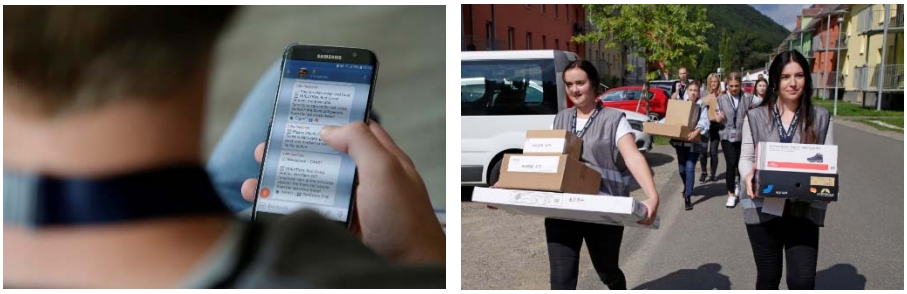

Fig. 3. Emergent groups organizing themselves with CrowdTasker Application

During the Trial, CrowdTasker was used to coordinate pre-registered volunteers as well as to evaluate computer-supported interaction with spontaneous, emergent groups that are not registered. Pre-registered volunteers were tasked with confirming observations on site both via the smartphone application and a chatbot interface. Emergent groups were guided in their activity as well as supported in coordinating amongst each other to achieve more complex goals such as setting up tents, providing drinking water, picking up medical equipment from a specific spot, etc.

3.2.2 Airborne Terrestrial Situational Awareness

Real-time aerial imaging significantly enhances situational awareness [19] during major and large- scale disasters. DLR's (German Aerospace Centre's) solution "Airborne and Terrestrial Situational Awareness" comprises of several modules (see also **Fig. 4**) to provide such a real-time aerial imaging and analysis system.

Module 1 is the ground control station U-Fly, used to plan, engage and monitor aerial missions. The full-size research aircraft D-CODE, which is operated as a drone demonstrator with safety pilots on board, allowing drone-based missions to be executed without regulatory restrictions or safety concerns, executes the missions.

Module 2 is the 3K aerial camera system, specifically developed to acquire and evaluate aerial photographs in near real-time. In addition, it can transfer aerial imagery via data link directly from the aircraft to a mobile ground station to provide the data to decision makers and rescue forces immediately.

Module 3 is the centre for satellite-based crisis information, which analyses aerial imagery and generates crisis information maps.

Module 4, called KeepOperational, has traffic analysis and route planning capabilities.

Within Trial-Austria, the ground control station U-Fly and the 3K system were selected to demonstrate their capabilities. U-Fly was used to create aerial missions based on the request of the operational commander. These can either be missions to assess larger areas of a (simulated) crisis or to monitor and investigate certain points of interest. The 3K system provided live aerial images of these missions to U-Fly to support an assessment of the overall situation on the ground.

During the execution of different scenarios in the Trial, the operational commander requested aerial images of a certain area by informing the U-Fly remote pilot. The remote pilot created a mission based on this request and activated the mission. The drone demonstrator, equipped with the 3K system, collected aerial images of the area and sent them to the ground immediately. The geo-referenced aerial images were displayed in U-Fly in near real-time and was provided to practitioners and other solutions (e.g. vieWTerra Evolution) via the Test-bed.

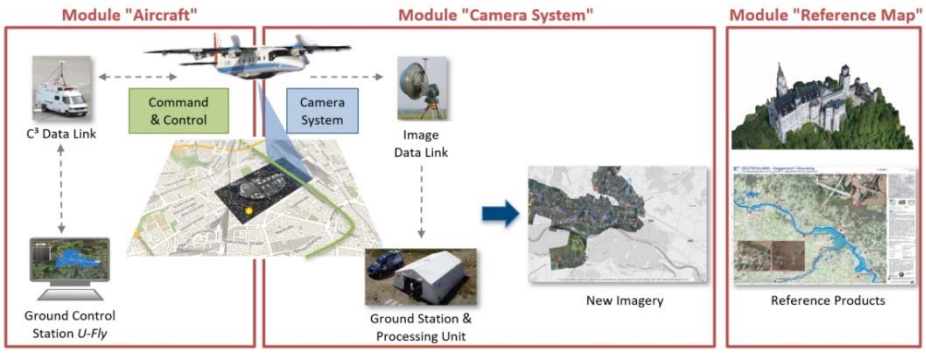

Fig. 4. DLR solution modules used in Trial-Austria

Fig. 5. DLR solution in flight planning
in the command centre of the Trial-Austria

3.2.3 vieWTerra Evolution

VWORLD's vieWTerra Evolution [20], vieWTerra Base, vieWTerra Mobile form a combined "GIS & Simulation" suite of products allowing responders to rapidly build a virtual 4D representation (3D synthetic environment + time dimension) of any potential crisis area on Earth. These solutions provide a Common Operational Picture to both the crisis centre and the rescue units out in the field. vieWTerra Evolution is a 4D earth viewer as well as a data & assets integration and development platform. It presents an ellipsoidal model of the earth allowing its users to integrate their own precise datasets anywhere on the globe, without any area coverage limitations, or to access data streams (e.g. imagery, cartography layers).

It can be used to model any type of 3D scene on earth and create scenarios at their real-world location to simulate events in the crisis preparedness phase, and to serve as a global repository for building a custom earth-wide GIS, either used perfectly off-line or ported on to an on-line architecture in order to allow sharing of multiple information, data and assets from disparate sources between all stakeholders in the crisis response phase (3D entities, icons, shapefiles, geotagged reports, photos, videos, sound, multiple overlays such as disaster maps, heat maps, tactical situation, etc.).

Within Trial-Austria, it was used to instantly visualize newly-acquired imagery from drone acquisition and photos taken from the field, shared in real-time with the crisis centre and displayed into/mixed with the 3D view. vieWTerra Mobile complementary software allows display of the same data & assets database in a plug-in free web-browser-based HTML5 app.

vieWTerra Evolution was used as the Trial's data sink, which means that all information output from each solution was provided via the Test-bed technical infrastructure to vieWTerra Evolution where it was visualized to support the decision-making process of the crisis managers.

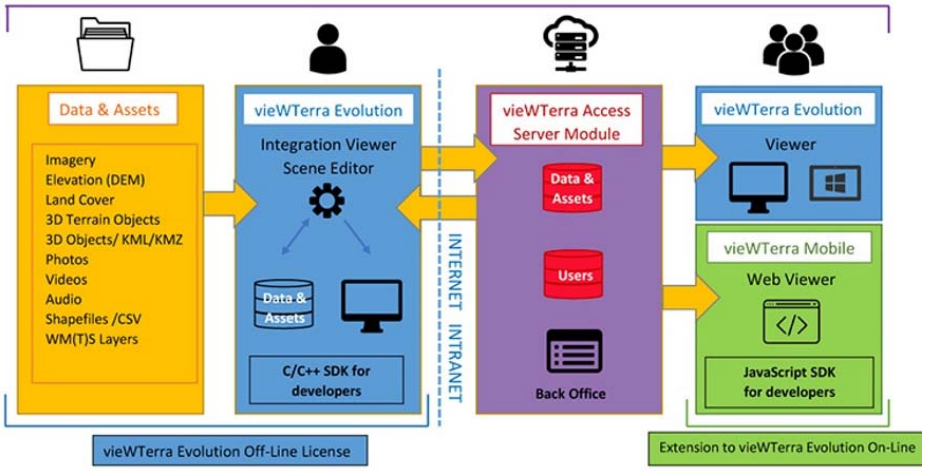

Fig. 6. VWORLDs vieWTerra Suite

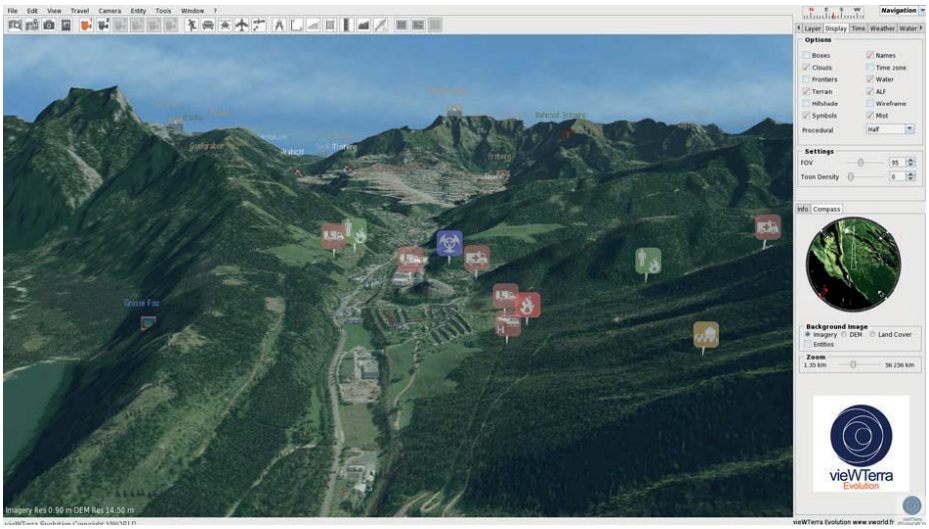

Fig. 7. vieWTerra Evolution visualizes in 3D the simulated environment all incoming crises relevant data and information

3.2.4 ASIGN

ASIGN is a solution by AnsuR Technologies [22] that helps reducing critical emergency and disaster response time. It is a complete all-in-one disaster assessment software tool for easy collection, optimal communication and effective management of operationally relevant critical information. ASIGN supports collection and communication of photos, videos, geo-texts, tracking, geo-zones, geo-alerts and assessment forms in a very bandwidth-efficient manner. Specifically, it can communicate photos and video with 99% bandwidth reduction, enabling communication even through low bandwidth cellular and satellite communication networks while maintaining full precision and accuracy. While the ASIGN Apps work perfectly with regular mobile networks, it also supports satellite communication (via Inmarsat BGAN [12]) to be used when needed.

ASIGN is comprised of the ASIGN Server, a cloud-based platform from which the incoming information is managed, plus the field user applications ASIGN PRO and UAV-ASIGN, which collect and send information from the field to the server, all with end-to-end encryption. With up to 99% saving in cost and capacity, ASIGN photos and videos from the field can arrive 100x faster at their coordination centre destination.

ASIGN has been actively developed with, and used in the field by, the United Nations, police forces and civil protection entities.

During the Trial the main tasks of ASIGN were: marking of dangerous zones (especially usage of geo-zones and geo-alerts functionality); Communication of photos, videos, text and tracks using smartphones with ASIGN software applications; User and team management plus analysis of incoming data using the ASIGN server; Geo-spatial photo and video clip communication, with mapping integration, for providing improved visual situational understanding; Use of 360^0 videos in addition to regular photos; Use

of satellite communication via BGAN [12] where little bandwidth was available or no internet connection was possible by mobile devices (e.g. smartphones).

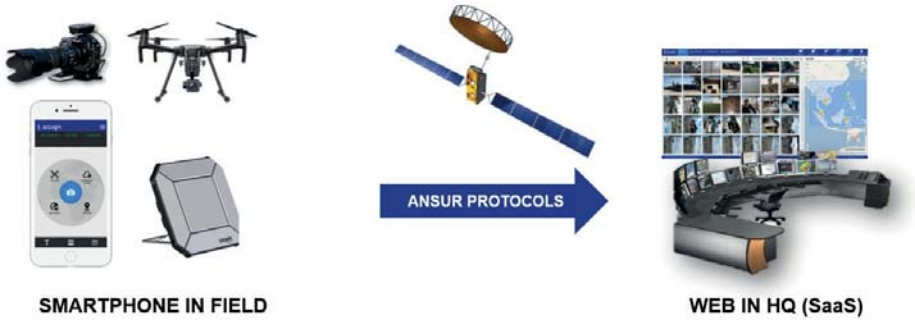

Fig. 8. ASIGN modules

3.2.5 PFA – Psychological First Aid

The psychological first aid (PFA) training (provided by the Danish Red Cross – as a non-technical solution) for spontaneous volunteers is a one-day training course, in which participants learn and get to practice the main skills needed to give good PFA in a crisis situation. They learn the internationally recognized principles of Look Listen Link, developed by the World Health Organization (WHO) [20]. The training includes sessions on these three principles as well as role plays, discussion sessions, sharing of knowledge and experience between the participants. Organizations responding to a crisis can implement the training to leverage the resources that spontaneous volunteers bring to a crisis in a positive and safe way.

The leadership seminar for engaging with spontaneous volunteers in crisis response combines the WHO's Look Listen Link principles for PFA, knowledge of caring for volunteers and theory on power relations to build the skills of field level leaders working for crisis response organizations to engage with spontaneous volunteers during crisis response. Through a series of exercises, analytical sessions, roleplays and discussion and reflection sessions, the participants activate their own experience and knowledge and learn from each other to be better placed to engage positively and constructively with spontaneous volunteers.

The ultimate goal of the solution is to alleviate human suffering and foster resilient societies.

The training contributes to this goal by supporting crisis management organizations' staff, so they can engage positively with spontaneous volunteers, and by building the capacity of PFA providers to deliver quality support.

Psychological first aid is a method of helping people in distress, so that they feel calm and supported in coping with their challenges. It is a way of assisting someone to manage their situation and make informed decisions. The basis of psychological first aid is caring about the person in distress. It involves paying attention to the person's

reactions, active listening and, if needed, providing practical assistance, such as problem solving or help to access basic needs.

Both the leadership seminar as well as the PFA training for spontaneous volunteers where given during the Trial-Austria and practiced in different exercises throughout the course of the Trial.

Fig. 9. Psychological first aid and leadership training held by the Danish Red Cross as a non-technical solution in Trial-Austria

3.3 Solutions connected, monitored and evaluated via the Test-bed technical infrastructure

Fig. 10 provides the final data exchange diagram for Trial-Austria. It shows all solutions used during the Trial and which output they give to participants and how these participants interact with them. It also illustrates data flows of these solutions to/from the Test-bed technical infrastructure and which components of the Test-bed technical infrastructure are used.

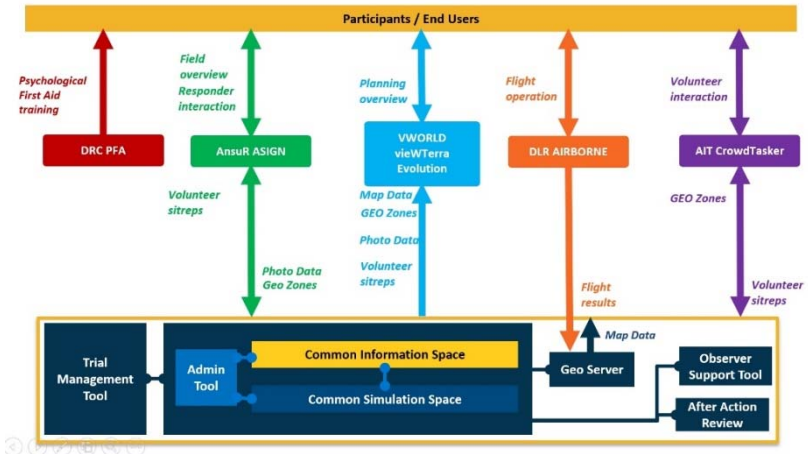

Fig. 10. Solutions' interactions via Test-bed

4 Conclusion

Trial-Austria was the last one in the series of four Trials. All Trials were organized to operationalize and test Crisis Management solutions. A final demonstration will take place in November 2019 and will incorporate the outcomes of all previous Trials.

The first results and recommendations have already been provided for Trial Poland (May 2018) and Trial France (October 2018) on the dedicated Trial section of the DRIVER+ website [13]. Subsequent paragraphs, however, are intended.

A first analysis of the feedbacks given for Trial-Austria was that commanders rated the exchanged and provided information as very valuable, impressive and innovative regarding decision making in the view of Crisis Management. All practitioners were impressed by the engagement and spirit of the solution providers working together in the Trial-Austria. One of the statements was "I got in contact with great experts of different countries' professionals and researchers from all over EU!".

Solution providers found it very valuable to see practitioners interacting with the operators of the solutions, on the one hand commanding them (learning the commander's speech) and on the other hand getting immediate recommendations and insight what functionality could be improved or was missing in their solution. This helped each solution provider to identify room for improvements and implement additional functionalities.

All outcomes (e.g. feedbacks to the Trial from Trial observers, Trial practitioners, Trial committee, etc.) as well as lessons learnt will be reported in an Evaluation Report Deliverable by the end of the project (in April 2020).

For now, we can only provide some first initial lesson learnt statements:

- TGM has proven to be valuable support tool for setting up Trials.
- Setting up a Trial as a field exercise (e.g. including the testing of field components) can quickly become an enormous organisational and logistical challenge. Reducing the number of solutions to be tested would help to

reduce the overall complexity. The same is true for testing solutions in parallel.

- The Test-bed technical infrastructure has proven stable in the way that all solutions could connect and exchange the requested information and data (e.g. images from the DLR solutions, videos from AnsuR solutions, messages from AIT's solutions) in the needed timeframe.
  Still, the adaptation work for the solutions to connect to the Test-bed as well as to implement use-cases for the Trial scenario and to test them all is very time consuming.
- Installation of international observers and practitioners needs a lot of preparation, coordination and training efforts.
- Support tools (e.g. Observer Support Tool, Trial Management Tool, etc.) are very valuable when it comes to evaluation of questionnaires and performance of solutions, but the time needed to prepare all the questionnaires related to injects played within the scenarios and sub-scenarios should not be underestimated.
- … more lessons learnt, and recommendation will be provided in the Evaluation Report Deliverable. So please keep track on the DRIVER+ website [13] on all upcoming reports and deliverables.

Finally, to mention is that all solutions tested in the Trials can be found in DRIVER+ Portfolio of Solutions (PoS) [14, 15]. It is an online catalogue to access information about innovative solutions for Crisis Management. For each solution, practitioners can share their user experiences and solution providers can give background information and offer support. The PoS is currently being scaled up and has the ambition to become the leading platform and one-stop-shop for Crisis Management solutions in Europe.

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This Trial owes a lot to the professionals of the Austrian Red Cross acting as commanders during the Trial as well as the link to the IRONORE2019 [9] exercise, which brought their professionalism, suggestions and recommendations for further improvements to the Trial, and demonstrated a very impressive and gratifying commitment in the management and execution of the various Trial scenarios but also in the feedback discussion that followed.

The observers, with their professional experience as commanders, teachers and evaluators to this Trial brought a precious methodological perspective for the evaluation, as well as an encouraging feedback.

The students and teachers from the Young Business School in Eisenerz (BHAK) [16] acting as volunteers for the emergent group scenarios testing the CrowdTasker

application and taking part in the PFA training and providing their valuable feedbacks on solutions as well as on the trainings.

We would like to express our gratitude to all of them.

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