driver+

Driving Innovation in Crisis Management for European Resilience

D924.21 – TRIAL SPECIFIC TEST-BED IMPLEMENTATIONS

SP92 - TEST-BED

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The DRIVER+ project

Current and future challenges, due to increasingly severe consequences of natural disasters and terrorist threats, require the development and uptake of innovative solutions that are addressing the operational needs of practitioners dealing with Crisis Management. DRIVER+ (Driving Innovation in Crisis Management for European Resilience) is an FP7 Crisis Management demonstration project aiming at improving the way capability development and innovation management is tackled. DRIVER+ has three main objectives:

1. Develop a pan-European Test-bed for Crisis Management capability development:
    a. Develop a common guidance methodology and tool, supporting Trials and the gathering of lessons learnt.
    b. Develop an infrastructure to create relevant environments, for enabling the trialling of new solutions and to explore and share Crisis Management capabilities.
    c. Run Trials in order to assess the value of solutions addressing specific needs using guidance and infrastructure.
    d. Ensure the sustainability of the pan-European Test-bed.
2. Develop a well-balanced comprehensive Portfolio of Crisis Management Solutions:
    a. Facilitate the usage of the Portfolio of Solutions.
    b. Ensure the sustainability of the Portfolio of Solutions.
3. Facilitate a shared understanding of Crisis Management across Europe:
    a. Establish a common background.
    b. Cooperate with external partners in joint Trials.
    c. Disseminate project results.

In order to achieve these objectives, five Subprojects (SPs) have been established. **SP91 *Project Management*** is devoted to consortium level project management, and it is also in charge of the alignment of DRIVER+ with external initiatives on Crisis Management for the benefit of DRIVER+ and its stakeholders. In DRIVER+, all activities related to Societal Impact Assessment are part of **SP91** as well. **SP92 *Test-bed*** will deliver a guidance methodology and guidance tool supporting the design, conduct and analysis of Trials and will develop a reference implementation of the Test-bed. It will also create the scenario simulation capability to support execution of the Trials. **SP93 *Solutions*** will deliver the Portfolio of Solutions which is a database driven web site that documents all the available DRIVER+ solutions, as well as solutions from external organisations. Adapting solutions to fit the needs addressed in Trials will be done in **SP93**. **SP94 *Trials*** will organize four series of Trials as well as the Final Demo (FD). **SP95 *Impact, Engagement and Sustainability***, is in charge of communication and dissemination, and also addresses issues related to improving sustainability, market aspects of solutions, and standardisation.

The DRIVER+ Trials and the Final Demonstration will benefit from the DRIVER+ Test-bed, providing the technological infrastructure, the necessary supporting methodology and adequate support tools to prepare, conduct and evaluate the Trials. All results from the Trials will be stored and made available in the Portfolio of Solutions, being a central platform to present innovative solutions from consortium partners and third parties, and to share experiences and best practices with respect to their application. In order to enhance the current European cooperation framework within the Crisis Management domain and to facilitate a shared understanding of Crisis Management across Europe, DRIVER+ will carry out a wide range of activities. Most important will be to build and structure a dedicated Community of Practice in Crisis Management, thereby connecting and fostering the exchange of lessons learnt and best practices between Crisis Management practitioners as well as technological solution providers.

Executive summary

Within the DRIVER+ project, the Test-bed Technical Infrastructure (TTI) was designed and implemented to technically support four Trials and the Final Demo that were defined in accordance with the Trial Guidance Methodology (TGM). This document describes how the TTI and its components were implemented for each of these five events and includes lessons identified and learned during the complete DRIVER+ project.

In Trial Poland, which was situated around a chemical flood scenario, a total of three solutions were trialled (**D943.11** (1) and **D943.12** (2)). In this Trial, all solutions and one simulator were connected to the TTI. Initial versions of the Common Information Space (CIS), Common Simulation Space (CSS), Observer Support Tool (OST) and Admin Tool were operational during this Trial. Trial France was about a wildfire scenario and had four solutions to trial, all connected to the TTI via the CIS component (**D944.11** (3) and **D944.12** (4)). One legacy tool was used inside this Trial as well, but this one had no connection to the TTI. Three simulators were used, of which two were connected to the TTI via the CSS. The same TTI components as in Trial Poland were used, except for the Observer Support Tool. In Trial The Netherlands, in which a large flood scenario was run, five solutions, one legacy system and three simulators were used (**D946.11** (5) and **D946.12** (6)). All solutions and the legacy system were connected to the TTI. This Trial also included the CIS, CSS, Admin Tool including security, Trial Management Tool with Time Service, Observer Support Tool and After Action Review tool. Trial Austria was run amidst a large earthquake live-exercise and had a total of five solutions to be trialled (**D945.11** (7) and **D945.12** (8)). Only four solutions had to be connected to the TTI via the CIS. No simulators or legacy tools were used. The CIS, Admin Tool, Trial Management Tool with Time Service, Observer Support Tool, After Action Review tool and GeoServer were configured and working. Although the Final Demo is still to be executed when publishing this deliverable, the preparation phase has progressed enough to include parts of it into this deliverable. In the Final Demo, several wildfires will be simulated in a fictive non-EU country, to which the Union's Civil Protection Mechanism will be activated. In this setting, five solutions, three legacy systems and two simulators are going to be used (more information to be included in future deliverables **D947.11** (9) and **D947.12** (10)). All except for one simulator and the legacy systems are connected to the TTI by means of the CIS and CSS. All TTI components are going to be configured and used during the Final Demo.

From these Trial-specific implementations of the TTI, the following lessons were identified:

- Necessity for a Large File Service and GeoServer, need for a Python adapter, provide a stable storage facility for recording logs relevant for evaluation, provide substantial internet bandwidth and connectivity for an online TTI and facilitate offline use of the OST (i.e. all of technical nature).
- Perform load tests, include TTI components inside these load tests and test for undesired participant interactions (i.e. all regarding technical tests)
- Introduce a Trial Integration Meeting, make as early as possible a clear decision on which TTI components to use, resolve planning congestions in the use of TTI components as soon as possible, focus on the Data Collection Plan and explicitly ask solution providers to store their logs after each Trial session (i.e. all regards to planning and communication).
- Create training material for TTI and provide an understanding on what the TTI can do for evaluation purposes, provide support on the usage of TTI components, and make sure progress is maintained with all perspectives of a Trial (i.e. these lessons apply primarily to TTI implementation support).

15 of the 17 lessons identified were already implemented inside later DRIVER+ Trials and the Final Demo. Over the course of the project, the amount of lessons identified decreased. This indicates the TTI and its components are stable and suitable to be used in preparing, executing and evaluating a Trial. Every Trial provided its own challenges regarding the TTI implementation of its components. Therefore, specific content-related attention is still required in the preparation of every event in which the TTI is used. A close interaction in between teams working on scenario, evaluation, solutions and simulator, platform and technical infrastructure is essential in deploying a TTI that serves and supports the needs of that event. Although current documentation, training material and the TTI open-source code base seem to be effective in implementing the TTI, support by an active (technical) community is very useful to help implement the TTI into future Trials, exercises and/or experiments.

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List of Acronyms

Acronym	Definition
AAR	After Action Review
AT	Admin Tool
CIS	Common Information Space
COP	Common Operational Picture
CSS	Common Simulation Space
DCP	Data Collection Plan
DEM	Digital Elevation Map
FTP	File Transfer Protocol
LFS	Large File Service
OST	Observer Support Tool
TTI	Test-bed Technical Infrastructure
TGM	Trial Guidance Methodology
TIM	Trial Integration Meeting
TMT	Trial Management Tool
TS	Time Service

1. Introduction

Within the DRIVER+ project, the Test-bed Technical Infrastructure (TTI) was designed and implemented to technically support Trials that were defined in accordance with the DRIVER+ Trial Guidance Methodology (TGM). Four Trials and a Final Demo were conducted to demonstrate and further develop the functionalities and capabilities of both the TTI and the TGM. This deliverable focuses specifically on how the TTI and its components were implemented for each Trial and the Final Demo. It includes the lessons identified at each Trial and while preparing the Final Demo and how these lessons were implemented in the organization of a consecutive Trial or the Final Demo.

Readers of this document are assumed to have a basic understanding of the objectives and work done within the DRIVER+ project. Readers new to this technical infrastructure or Trials, or who would like to gather more elaborate explanations on these, are referred to the following deliverables:

- For a complete description of the TTI, its design and documentation on how to implement and use it, the reader is referred to **D923.11** ***Functional specification*** (11) and **D923.23** ***Reference implementation v3*** (12).
- For reports about Trial Poland (formerly called Trial 1) the reader is referred to **D943.11** ***Report on Trial Action Plan - Trial 1*** (1) and **D943.12** ***Report on Trial Evaluation – Trial 1*** (2).
- For reports about Trial France (formerly called Trial 2) the reader is referred to **D944.11** ***Report on Trial Action Plan - Trial 2*** (3) and **D944.12** ***Report on Trial Evaluation – Trial 2*** (4).
- For reports about Trial The Netherlands (formerly called Trial 4) the reader is referred to **D946.11** ***Report on Trial Action Plan - Trial 4*** (5) and **D946.12** ***Report on Trial Evaluation – Trial 4*** (6).
- For reports about Trial Austria (formerly called Trial 3) the reader is referred to **D945.11** ***Report on Trial Action Plan - Trial 3*** (7) and **D945.12** ***Report on Trial Evaluation – Trial 3*** (8).
- For reports about the Final Demo the reader is referred to **D947.11** ***Report on Trial Action Plan – Final demo*** (9) and **D947.12** ***Report on Trial Evaluation – Final demo*** (10).

This deliverable is written for readers interested in how the TTI was implemented for each Trial and the Final Demo, and for everyone wanting to implement the TTI in a future Trial, experiment or exercise and to learn from the current implementations done.

The reported lessons identified were obtained via multiple ways. Within each Trial, close interaction with TTI component developers, internal and external solution providers, Trial Committee members, and participants and observers allowed to identify these lessons. These interactions were recorded over the numerous channels of communication:

- Online/remotely in the form of e-mail conversations, questions and answers via the DRIVER-EU Slack channel and issues being reported on the GitBook (13) and GitHub repositories (14).
- Project internal working sessions and face-to-face meetings (i.e. Trial Integration Meetings, Dry Runs, Workshop 0, updated Workshop 0 and Technical Review meetings).
- Lesson Learned meetings after each (day of a) Dry Run 2 and Trial execution.

In the development of the TTI components, stakeholders and advisors were used to design and improve the components tailored to be fit for purpose. For instance, understanding the military exercise management tool JEMM was very helpful in improving the Trial Management Tool (TMT), whereas observers and evaluation coordinators of Trials provided useful feedback to the Observer Support Tool (OST).

The structure of this deliverable is as follows: Section 2 until 5 describes the specific TTI implementation done for and the lessons identified and learned from Trial Poland, Trial France, Trial The Netherlands and Trial Austria respectively. Section 6 describes the foreseen specific TTI implementation for the Final Demo. Finally, recommendations with respect to the future use of the TTI are presented in section 7.

2. Trial Poland – Chemical spill scenario at SGSP, Warsaw

Trial Poland, which was executed in May 2018 (M49 of the project runtime) was the first implementation of the DRIVER+ Trial Guidance Methodology (TGM) and comprises the initial core of the Test-bed Technical Infrastructure (TTI). The local Platform acting as the Trial Poland testing environment, in which the TTI was deployed, was the Main School of Fire Service – SGSP, in Warsaw.

During Trial Poland, the first version of the Test-bed reference implementation was available (see **D923.11** (4) and the DRIVER+ Gitbook (13)) and all its then implemented components were used and tested.

In order to properly describe the TTI implementation done for this Trial, subsection 2.1 and 2.2 provide an overview of the solutions and facilitating components used for Trial Poland respectively. Subsection 2.3 describes the architecture to connect these solutions and components and what and how data is exchanged. Lessons identified during the Trial are described in subsection 2.4.

2.1 Overview of solutions and use-cases

Table 2.1: Overview of Solutions assessed and their use-cases in Trial Poland

Solution / legacy system and its use	Short description
3Di	3Di is a cloud-based versatile water manage-ment instrument that enables flood forecas-ting and risk mapping. 3Di models are fast, accurate and visual. 3Di results present flooding locations, water depths, arrival times and damages in high detail. Moreover, flood mitigation measures can be modelled for their effectiveness. Experts and decision-makers can interact with the model to simulate dike breaches, rain events and storm surges.
Use-cases tested: • Publish current flood map progression. • Visualize mitigating measures.	
SOCRATES OC (SOC)	SOCRATES OC enhances analysis and decision-making capabilities by means of an improved shared situational awareness based on relevant information about the operational situation including crisis events, missions and resources. The information is created by the operator or coming from external sources. The information is displayed on a Common Operational Picture (COP).
Use-cases tested: • Visualize Common Operational Picture (COP). • Visualize emergency resources from XVR RM. • Visualize current flood map from 3Di. • Visualize incident drone imagery from DRM.	
Drone Rapid Mapping (DRM)	At Trial Poland, Drone Rapid Mapping was named Hexagon. In order to avoid confusion within this deliverable, the current name is used. Drone Rapid Mapping enables rapid mapping of incident/crisis area. The solution enables very fast generation of orthophoto maps based on imagery acquired by any drone (RPAS) available to rescue or crisis management actors. The resulting maps can be viewed and analysed in the dedicated geoportal or any GIS environment already utilized by crisis management institutions. The

	additional product is a 3D terrain model, enabling better and more intuitive understanding of the area of interest.
Use-cases tested: • Fly reconnaissance drone over incident area. • Publish incident drone imagery to SOC.	

2.2 Overview of facilitating components and simulators used

Table 2.2: TTI components and simulators used in Trial Poland

TTI component/simulator	Reason for (not) using it
Common Information Space (CIS)	Used to share information between all solutions, and to receive simulated data representing the fictional crisis.
Common Simulation Space (CSS)	Used to share the simulation data from XVR RM, via the TTI resource gateway, with the solutions so they could visualize and work with a fictional yet realistic crisis.
TTI adapters	• **JavaScript adapter** for 3Di and DRM. • **Java adapter** for SOC. • **C# adapter** for XVR RM.
Admin Tool (AT)	Used to technically configure and monitor all connected solutions, components and simulators.
Security	Not yet implemented, but also not needed for Trial Poland, since this was a local deployment of the TTI at an anyhow enclosed and secured platform.
Trial Management Tool (TMT) + Time Service (TS)	Under development at the moment of Trial Poland. Instead of the TMT, a scenario script inside an Excel file was used and experienced sufficient to keep track of the scenario.
Observer Support Tool (OST)	Under development at the moment of Trial Poland. Instead of the OST, paper questionnaires were planned to be used by the observers during the Trial. However, between Dry Run 2 and the Trial the decision was made to use OST by several observers by means of a test.
After Action Review tool (AAR)	Under development at the moment of Trial Poland and therefore not used.
Large File Service (LFS)	Not in scope at the moment of Trial Poland.
GeoServer	Not in scope at the moment of Trial Poland.
XVR Resource Management (XVR RM)	Used to simulate crisis management resources (primarily firefighting units) that could be visualized by the SOC solution.

2.3 IT architecture and data exchanges

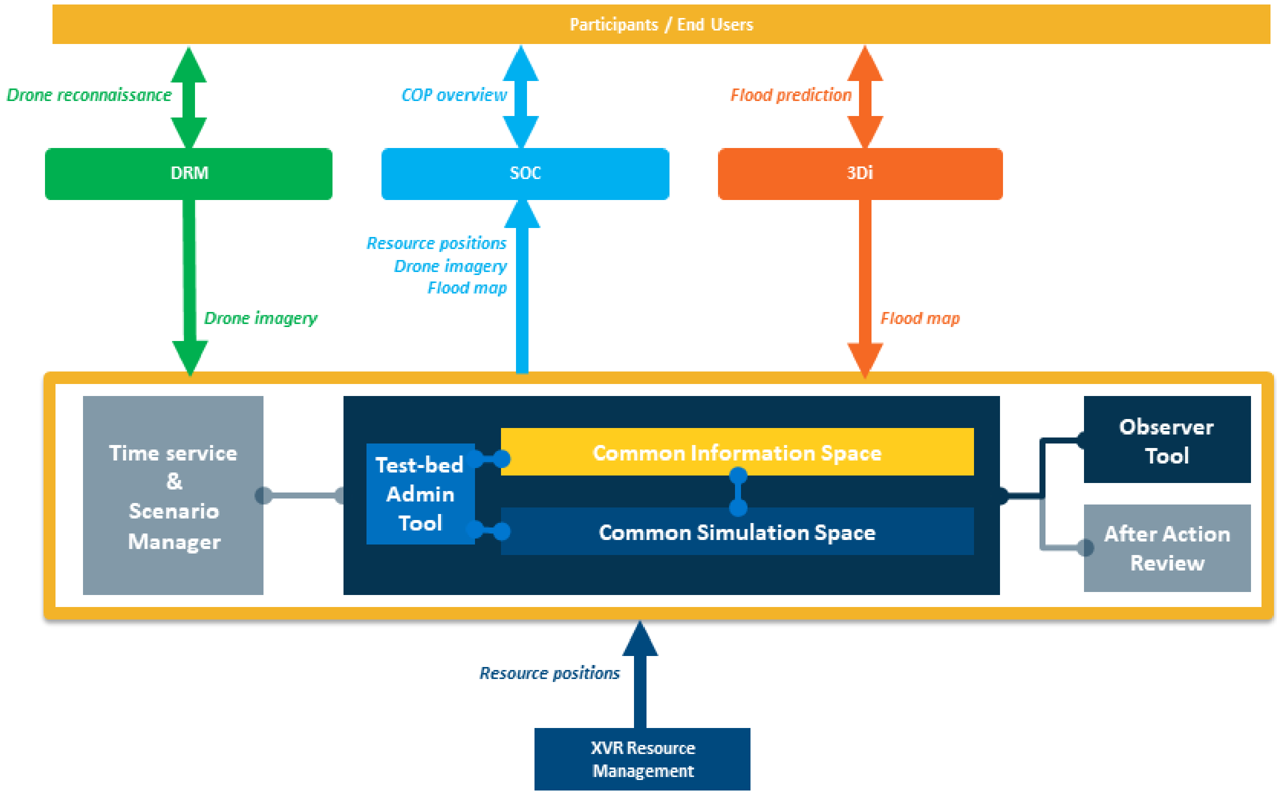

Figure 2.1: Data Exchange Diagram for Trial Poland

The Data Exchange Diagram depicted in Figure 2.1, shows the interconnectivity of all solutions and simulators, and the TTI components, to execute the Trial Poland. Starting from left to right, this section describes each interaction (depicted as arrows) drawn in the Data Exchange Diagram.

During this Trial, DRM was able to fly a drone above a given area in Poland to allow participants to go through the complete process of acquiring imagery from the drone. The results from these flights were processed and sent out as a map layer to SOC.

SOC provided a COP overview of all provided solution and simulator data to be used by the participants in the decision-making process. This included the drone imagery from DRM, the current flood map from 3Di and the resource positions from XVR RM.

3Di provided several generated flood map updates over time to be visualized at SOC, simulating the chemical spill moving across the incident area. These flood maps were first uploaded to a storage server before sending an update message to SOC. Whenever SOC received this update message, it downloaded the flood data into its own geo server and transformed it into a readable format for the SOC solution, sending out this map layer update to the solution. 3Di also allowed participants to visualize and calculate mitigating measures inside its own solution.

XVR RM was used to simulate resources at the incident area. Controlled by the Trial staff, the resource locations were sent through to SOC via the resource gateway to visualize those resources on the map.

The described Data Exchange Diagram has been further specified and implemented as shown in Figure 2.2. This figure enhances the Data Exchange Diagram by defining which topics (i.e. channels for applications to send and receive messages over) are used and what schema is used for each topic (i.e. the type and format of message to send and/or receive).

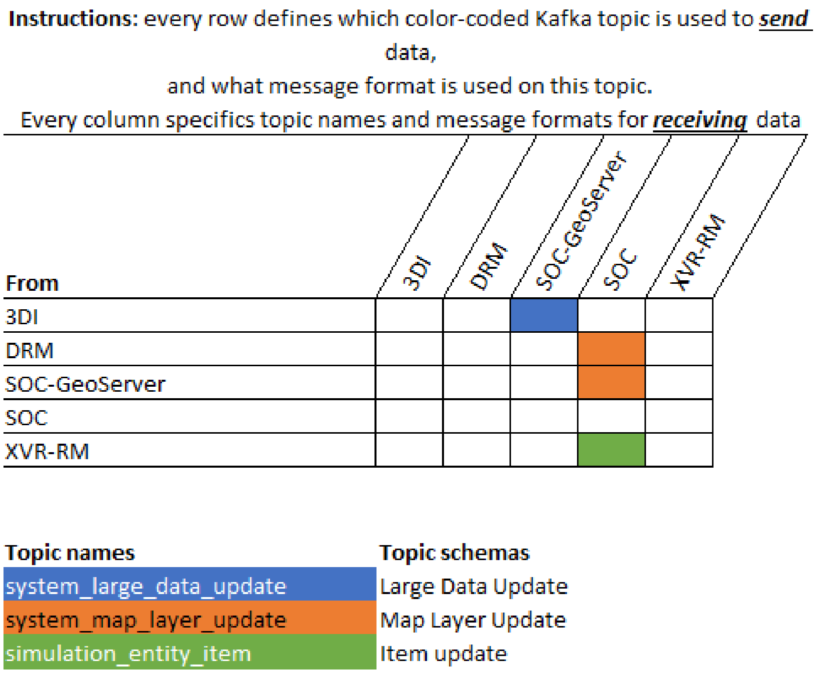

Figure 2.2: TTI topic configuration for Trial Poland

2.4 Lessons identified on the use of the Test-bed Technical Infrastructure

In general, as the development of the TTI just started at the time of this Trial, Trial Poland had a limited set of TTI components available. The components that were available during the Trial run were working as intended and did not cause major problems. Table 2.3 lists the lessons identified in this Trial.

Table 2.3: Lessons identified in Trial Poland

Lesson category	Lesson
Technical	**Necessity for a Large File Service & GeoServer**
An important functional requirement of the Trial could not be addressed adequately by the TTI: sharing of large files. Both 3Di output data and DRM large geo-images were too large to be shared directly over the TTI. Instead, the Trial Support team needed to set up a shared FTP site, SOC provided its own geo server to be used inside the Trial. This worked well during the Trial, although it was agreed that the next version of the TTI should provide proper support for sharing large files.	
Technical	**Necessity for a Python adapter**
A missing element was the lack of a Python adapter. The 3Di solution used Python to process all data, and it proved difficult to handle them in such a short time. The solution provider had to adapt to use one of the other adapters in a separate application, instead of integrating it into their current code base. It was agreed that the next version of the Test-bed reference implementation would have to include a Python adapter.	
Technical	**Perform load tests**
During Trial Poland, SOC had problems with receiving the update messages from XVR RM containing resource positions. This issue resulted in a very slow performance of the solution gradually over time, while the solution was performing correctly when starting the Trial. After further investigation after the Trial, developers at SOC found a memory leak inside their implementation of handling the resource update messages causing the gradual degrading of the solution. Because this investigation could not be done during the Trial, the decision was made to stop the XVR RM simulator and manually update the	

resource positions inside SOC by the Trial staff. Although this technical issue could have been spotted during the Dry Runs, it was not. Additional load tests on top of the regular tests need to be performed to make sure these degradation issues can be spotted and dealt with sooner.	
Technical	**Facilitate offline use of the OST**
Trial Poland had a part of the Trial run at an external location with no access to internet where the observers also required the OST to be functioning. First design and implementation of the OST however did not take into account the functionality of using it outside of a stable Wi-Fi network. The lesson identified is to include the functionality of the OST to be used without continuous connection to its server, so it can be used in outside areas without an internet connection.	
Planning	**Make clear decision on whether or not to use TTI components as early as possible**
During this Trial the OST was partially used, although not fully defined and tested during Dry Run 1 and Dry Run 2. This led to what best can be described as a testing session of the OST inside the actual Trial, which resulted in the realization by the Trial Committee that the functionality of the OST wasn't functioning correctly and resorting into switching all observers back to paper questionnaires. Given that this fall-back plan had been the original plan from Dry Run 1 and 2, the Trial Committee was already prepared for this. However, this issue clearly pointed out the importance of testing TTI components during Dry Runs and having proper decisions made during or right after those Dry Runs to either include entirely, include with additional fixes that are possible within the next deadline, or exclude certain components.	
Planning	**Introduce a Trial Integration Meeting**
During the process of going through the TGM-described procedure of Dry Run 1, Dry Run 2 and Trial, it was noticed early on that having the first face-to-face meeting with technical, scenario, evaluation and logistical perspectives at the Dry Run 1 was putting a lot of time pressure on the rest of the procedure. The alignment of all perspectives participating in the Trial needs to be done as soon as possible, and can best be done with a newly introduced face-to-face meeting, called the Trial Integration Meeting (TIM). This meeting allows for people to come together and define the initial scenario of the Trial, while also describing the technical limitations and possibilities of the solutions partaking in the Trial. This would help focus all perspectives on the Dry Run 1 and the period between TIM and Dry Run 1 for the technical perspective to implement desired functionality and interoperability.	
Support	**Create training material for TTI**
It was noticed that the lack of adequate training material for the local SGSP staff to use the TTI also caused some delays during the development and preparation phases before the Trial. This training material will be created as part of the Training Module. In order to give proper time for this training material to be created, more TTI developers were actively involved and present during the following Trials in order to provide direct support at TIM, Dry Runs and Trial.	

3. Trial France – Wildfire scenario at CESIR, Valabre

Trial France was executed in October 2018 (M54) and was the second implementation of the DRIVER+ TGM and comprised the initial core of the TTI.

The CESIR simulation centre of Valabre was the local platform acting as the Trial France testing environment, in which the TTI was implemented. This platform was adapted to allow an adequate integration and utilisation of the solutions and simulators.

In order to properly describe the TTI implementation done for this Trial, subsection 3.1 will briefly explain which lessons identified by previous Trials were implemented. Subsection 3.2 and 3.3 provide an overview of the solutions and facilitating components used for Trial France respectively. Subsection 3.4 describes the architecture to connect these solutions and components and what and how data is exchanged. Lessons identified during the Trial are described in subsection 3.5.

3.1 Lessons implemented

Although the time in between execution of Trials Poland and France was short and preparations of both Trials occurred partly simultaneously, a couple of lessons from Trial Poland were implemented in Trial France, as listed in Table 3.1.

Table 3.1: Lessons implemented in Trial France

Lesson category	Lesson
Technical	**Perform load tests**
At the end of Dry Run 2 of Trial France, a technical load test was performed to find any degradation problems inside solutions, simulators and the platform infrastructure.	
Planning	**Make clear decision on whether or not to use TTI components as early as possible**
Firm decisions were made based on the current implementations of the TTI components. As shown in the lessons identified from Trial France, this unfortunately led to another lesson identified.	
Support	**Create training material for TTI**
Although the Training Module was still under development, active support and guidance from the DRIVER+ development community was provided to solution providers and platform facilitators.	

3.2 Overview of solutions, legacy systems and use-cases

Table 3.2: Overview of Solutions assessed and their use-cases in Trial France

Solution / legacy system and its use	Short description
LifeX COP	LifeX COP is a web-centric multi-user solution developed by Frequentis to address the lack of a Common Operational Picture in the field of Crisis Management. LifeX COP is able to collect information from various data sources (static or dynamic) and present them in a map-centric user interface.
Use-cases tested: • Visualize Common Operational Picture (COP). • Visualize ambulance unit locations. • Visualize situation reports.	

• Publish danger areas.	
MDA Command and Control system (MDA)	MDA C4I system allows for efficient, real time response to tasks on the field (e.g. people in need for medical assistance), by allocating the site, allocating the resources needed and available, tasking the resources, and following up the accomplishment. This can be achieved for large number of incidents simultaneously and for large number of resources to the same task, grouping them if needed. The systems receive and disseminate information to dedicated apps both used by the general public as well as by the team members and volunteers.
Use-cases tested: • Visualize ambulance unit locations. • Dispatch ambulance units.	
CrisisSuite	CrisisSuite is a tool that supports the net centric working methods of crisis teams by creating a universal picture of the crisis and shares it horizontally and vertically with all the other teams in the crisis organization. CrisisSuite also assists in maintaining an effective crisis meeting structure and it decreases the administrative workload for the people managing the crisis.
Use-cases tested: • Create/Update logs and situation reports. • Publish situation reports.	
Social Media Analysis Platform (SMAP)	SMAP enables to find information relevant to a crisis in Social Media. Social Media contain information which can contribute to situation assessment. This information can concern the incident itself, its impact, or the needs of the population affected by the crisis.
Use-cases tested: • Analyse simulated Twitter messages for relevant information. • Publish analysis report.	
ASPHODELE	The Asphodèle system is the legacy tactical command and control in Valabre (and other departments) and is used to manage the fire resources and generate the Tactical situation (SITAC).
Use-cases tested: • Create/Update SITAC. • Publish SITAC.	

3.3 Overview of facilitating components and simulators used

Table 3.3: TTI components and simulators used in Trial France

TTI component/simulator	Reason for (not) using it
Common Information Space (CIS)	Used to share information between all solutions, and to receive simulated data representing the fictional crisis.
Common Simulation Space (CSS)	Used to share the simulation data from XVR RM and XVR CM, via the TTI resource and Twitter gateway respectively, with the solutions so

	they could visualize and work with a fictional yet realistic crisis.
TTI adapters	• **Java adapter** for LifeX COP. • **REST adapter** for CrisisSuite and SMAP. • **C# adapter** for MDA, XVR RM and XVR CM.
Admin Tool (AT)	Used to technically configure and monitor all connected solutions, components and simulators.
Security	Not needed for this Trial, since this was a local deployment of the TTI at an anyhow enclosed and secured platform.
Trial Management Tool (TMT) + Time Service (TS)	Under development at the moment of Trial France. Instead of the TMT, a scenario script inside an Excel file was used and experienced sufficient to keep track of the scenario. The time service was implemented, and partly used inside the Trial Staff room although the CESIR platform had its own Trial time tracking system for observers.
Observer Support Tool (OST)	Not used due to the inability for participation in the design process of Trial France. Trial Poland lessons learned also indicated the need for major improvements to the OST, but improvements were not yet ready for Trial France. Additional limitations of the Wi-Fi network at the platform, lead to the decision to replace the OST with paper questionnaires. One observer used the OST during Trial France to check progress of the OST functionalities.
After Action Review tool (AAR)	Still under development at the moment of Trial France and there-fore not used.
Large File Service (LFS)	Implemented at the moment of Trial France, but not needed for this Trial, because the solutions did not need to share large data.
GeoServer	Under development at the moment of Trial France, but not needed by the Trial since no solution had to visualize map data.
XVR Resource Management (XVR RM)	Used to simulate crisis management resources (primarily ambulance units) that could be visualized by the LifeX COP and MDA solutions, and manipulated by the MDA solution (i.e. given a dispatch command).
XVR Crisis Media (XVR CM)	Used to simulate Twitter messages about the fictive forest fire that needed to be detected by the SMAP solution.
XVR On Scene (XVR OS)	Used to provide 3D visuals of the incident scene and wildfire front. A different version of XVR OS (without connectivity to the TTI) was used at the CESIR platform because of extensive operator expe-rience with this specific non-coupled version. No coupling was needed because 3D visual simulation data was not required by one of the solutions.

3.4 IT architecture and data exchanges

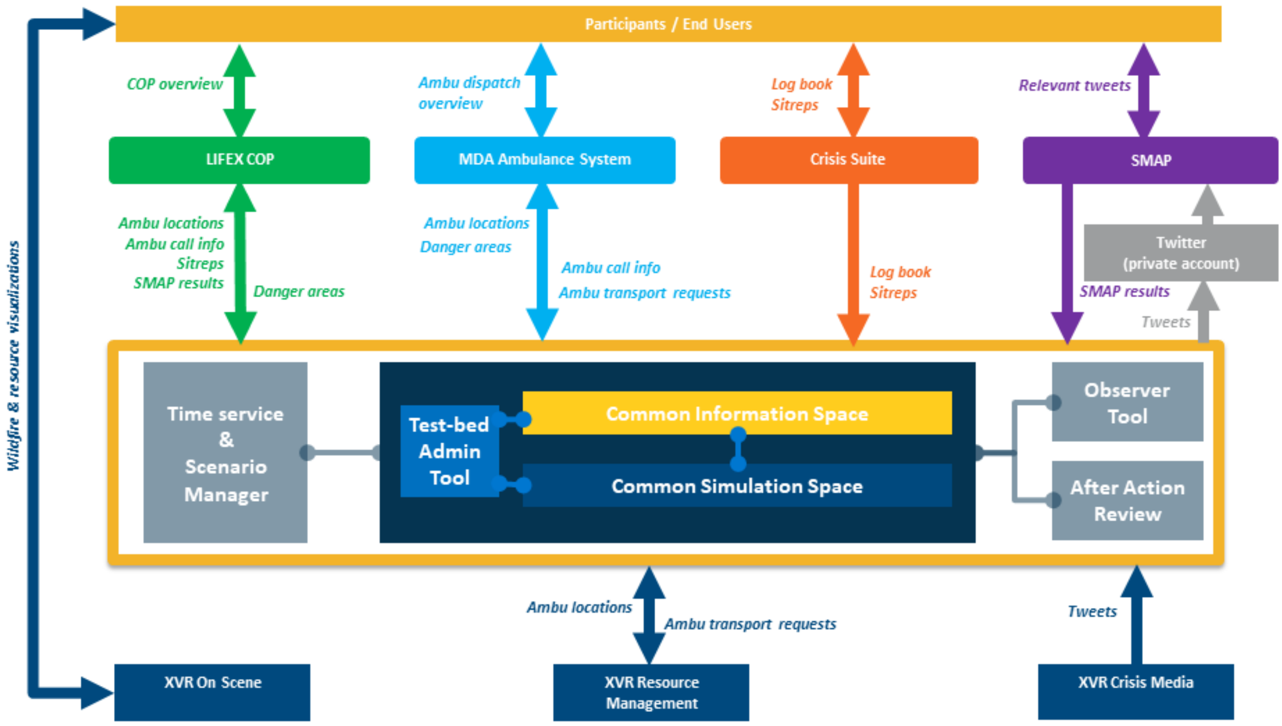

Figure 3.1: Data Exchange Diagram for Trial France

The Data Exchange Diagram depicted in Figure 3.1, shows the interconnectivity of all solutions and simulators, and the TTI components, to execute the Trial France. Starting from left to right, this section describes each interaction (depicted as arrows) drawn in the Data Exchange Diagram.

In order to provide participants with visual cues of a large fictive wildfire, XVR OS is used to allow them to move across this virtual incident and provide relevant information on how to address the current situation. This was primarily used for navigation and keeping visual track of requested resources coming to a designated collection point.

Being a Common Operational Picture (COP) Tool, LifeX COP received all messages coming from all connected solutions and simulators (except the Tweets from XVR CM, which were only directed to the Twitter gateway and to be used by SMAP). It also allowed for participants to draw danger areas, which are shared with MDA to make sure ambulances are avoiding these areas.

Both LifeX COP and MDA received and visualized ambulance locations maintained by the XVR RM simulator. This simulator mimicked all relevant ambulance units inside the fictive incident; which in reality is usually done by GPS tracking of real-life ambulance vehicles. MDA had a special interaction with XVR RM via the TTI to be able to send out transport requests via a calculated route. This allowed the MDA user to dispatch ambulance units, avoiding the danger areas as drawn in LifeX COP, consequentially receiving the updated positions of those units from XVR RM.

CrisisSuite and SMAP reported their relevant data to the TTI, to be received and visualized by LifeX COP. SMAP received numerous Twitter messages from different accounts for the SMAP user to filter out and publish relevant tweets relevant to the fire and its propagation. The tweets concerning the fire were sent out by XVR CM, via the TTI and Twitter gateway, to a private Twitter account SMAP listened to. This to make sure that the fictive tweets were not published to the outside world, possibly causing panic amongst Twitter users not participating in the Trial but reading these tweets anyhow.

The described Data Exchange Diagram has been further specified and implemented as shown in Figure 3.2. This figure enhances the Data Exchange Diagram by defining which topics (i.e. channels for applications to send and receive messages over) are used and what schema is used for each topic (i.e. the type and format of message to send and/or receive).

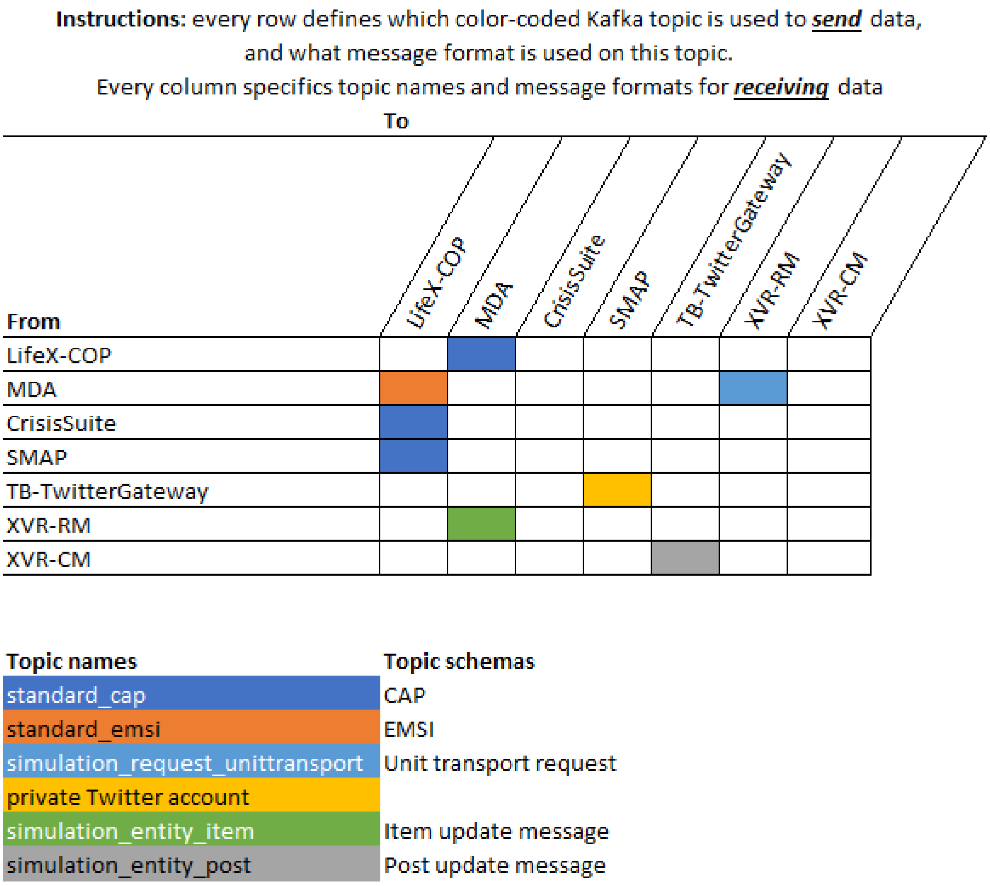

Figure 3.2: TTI topic configuration for Trial France

3.5 Lessons identified on the use of the Test-bed Technical Infrastructure

Trial France already started its preparation and development phases before the lessons identified and learned were presented from Trial Poland. Therefore, it was not possible to implement an important lesson learned from Trial Poland, namely to have a TIM prior to the Dry Run 1. This resulted in time pressure and misalignment between scenario, evaluation and technical perspective similar to Trial Poland. Table 3.4 lists the lessons identified in the French Trial.

Table 3.4: Lessons identified in Trial France

Lesson category	Lesson
Technical	**Test for undesired participant interactions**
At the start of the most technically challenging session, MDA reported a problem that was not encountered during the Dry Runs. One of the participants created a danger area completely covering the area where ambulances should be dispatched towards. This led to none of the ambulances being able to be dispatched, since MDA tries to calculate a route avoiding all danger areas. The functionality to remove a danger area was not implemented by the solution provider, so a complete reset of the TTI and all solutions was required to start the Trial session properly. Proper actions were taken to quickly reset everything and with only 15 minutes delay the Trial could continue. However, test plans created for	

future Trials should include proper handling of undesired participant interactions with the solutions.	
Technical	**Provide a stable storage facility for recording logs relevant for evaluation**
The previously mentioned issue had a cascading effect for the evaluation phase of Trial France. Because the error resulted in a TTI reset and the focus was on bringing back up the TTI, its components and connected solutions and simulators as soon and stable as possible, storing of the previous recorded TTI data was forgotten. After the reset, the manual storage mechanism was not behaving correctly anymore, resulting in a technical data loss of the complete day of the Trial. Luckily, the evaluation was primarily relying on the paper logs from the observers, but this made it very clear that the AAR is essential in providing a stable storage facility for storing technical logs relevant for evaluation. In future Trials, the AAR tool was implemented and used for solving these issues.	
Planning	**Focus on the Data Collection Plan**
The components of the TTI that are dedicated to data collection and evaluation were not properly available yet in Trial France. The decision by the Trial Committee to also exclude the OST from being used inside the Trial, lead to a very basic form of evaluation recording (i.e. performing continuous observation by observers with pen and paper, and having final questionnaires on paper as well). This was also a mis-conception between evaluation and technical perspectives about the data being logged by the TTI itself. Because the AAR wasn't yet present, an alternative was proposed to store all messages being sent via the TTI. Since all solutions were connected, this would help the evaluation phase in understanding what was technically going on during the Trial. Since the Data Collection Plan (DCP) was presented late in the preparation phase, no checks were made if the technical messages would indeed be relevant for measuring the described Key Performance Indicators (KPIs). Having a DCP as early as possible in the preparation phase would help the technical perspective to focus its attention in trying to provide the correct data for the requested measurements or at least provide a discussion on the limitations of providing that data.	
Planning	**Explicitly ask solution providers to store their logs after each Trial session**
Human observers are still needed in addition to the TTI to record more data that can be obtained from the participants. However, logs from solutions themselves (e.g. how long it took for a participant to dispatch an ambulance from clicking the first button in the solution to sending out the dispatch message) can be very useful as well. Unfortunately, those logs were not specified in the DCP and after the execution phase of Trial France were therefore not stored by the solution providers or handed over to the evaluation team. Miscommunication between evaluation, solution and technical teams led to logs being erased by several solutions, making it harder for the evaluation team of this Trial to run the analyses. An important lesson learned for the upcoming Trials is to include a session within the closing procedure to explicitly request all solution providers to store their logs.	
Support	**Provide an understanding on what the TTI can do for evaluation purposes**
Evaluation-wise, during this Trial it became clear that the TTI (and in particular AAR) in general might not provide all relevant data useful for the DCP. This primarily has to do with the fact that the AAR can only record messages being sent via the TTI. Responses of solutions to these messages and participants responding to changes inside solutions are not part of the TTI recording. Making sure the Trial Committee in future Trials are aware of what the TTI and its components can and cannot do for the evaluation phase is a lesson identified.	

Apart from these challenges, the implemented and used TTI components were working as intended during the complete Trial run. The TTI was stable, and even after the above described reset caused by a solution error, the complete implementation of the TTI was up and stable again in a matter of minutes.

4. Trial The Netherlands – Flood scenario at Safety Region The Hague, The Hague

Trial The Netherlands, which was executed in May 2019 (M61), was the third implementation of the DRIVER+ Trial Guidance Methodology (TGM) and comprises the full suite of the Test-bed Technical Infrastructure (TTI).

The TTI was deployed at an online server, to be monitored by technicians at the Safety Region The Hague simulation centre (i.e. the platform serving as the Trial The Netherlands testing environment). The reason for deploying the TTI and all its components online - instead of locally like in the previous two Trials - was that practically all solutions were using a server deployed on the internet.

In order to properly describe the TTI implementation done for this Trial, subsection 4.1 will briefly explain which lessons identified by previous Trials were implemented. Subsection 4.2 and 4.3 provide an overview of the solutions and facilitating components used for Trial The Netherlands respectively. Subsection 4.4 describes the architecture to connect these solutions and components and what and how data is exchanged. Lessons identified during the Trial are described in subsection 4.5.

4.1 Lessons implemented

Based on the previous Trials in Poland and France, the lessons listed in Table 4.1 are implemented in the set-up and execution of the Trial The Netherlands.

Table 4.1: Lessons implemented in Trial The Netherlands

Lesson category	Lesson
Technical	**Necessity for a Python adapter**
The Python adapter was created and used inside this Trial and is available for all following Trials.	
Technical	**Perform load tests**
At the end of Dry Run 1 and 2 of Trial The Netherlands, a technical load test was performed to find any degradation problems inside solutions, simulators and the platform infrastructure.	
Planning	**Make clear decision on whether or not to use TTI components as early as possible**
During the TIM and Dry Run 1, the TTI components were introduced to the Trial Committee. This helped align the needs of the Trial with the functionalities of the components. Although several components were having more issues in getting aligned with the Trial, all components were used eventually.	
Planning	**Introduce a Trial Integration Meeting**
A TIM was planned in advance for Trial The Netherlands. This meeting really proved its use during the process of creating a scenario where solutions were optimally used and evaluated. The scenario perspective could focus the implementation work at the technical perspective, while the technical perspective could easily explain limitations and opportunities to be used for steering the scenario. This rapidly created a clear and joint vision on the execution phase, keeping all involved parties informing each other about progress and potential conflicts and resolves.	
Support	**Create training material for TTI**
Although the Training Module was still under development, active support and guidance from the DRIVER+ development community was provided to solution providers and platform facilitators.	
Technical	**Test for undesired participant interactions**
From the start of Dry Run 1, additional test cases were introduced to make sure solutions were able to	

either limit or mitigate undesired user interaction.	
Technical	**Provide a stable storage facility for recording logs relevant for evaluation**
The AAR was implemented and working as intended during this Trial.	
Planning	**Focus on the Data Collection Plan**
The DCP was brought under the attention of all parties that could help with collection of this data. This provided a better understanding of what was important to log.	
Planning	**Explicitly ask solution providers to store their logs after each Trial session**
After each Trial session, the evaluation coordinator made sure all solutions and TTI components had stored their logs.	
Support	**Provide an understanding on what the TTI can do for evaluation purposes**
With the introduction of the TIM, and also during the presentations of the TTI components at the Dry Run 1, the Trial Committee was informed on the possibilities and limitations of the TTI regarding evaluation.	

4.2 Overview of solutions, legacy systems and use-cases

Table 4.2: Overview of Solutions assessed and their use-cases in Trial The Netherlands

Solution / legacy system and its use	Short description
Airborne and Terrestrial Situational Awareness (Airborne)	The solution "Airborne and Terrestrial Situational Awareness" is composed of several individual components and tools, which are integrated into a complete system, ready to be deployed in different scenarios. Based on the aerial images and additional data, information layers relevant for crisis management will be derived and provided as geo-web services and map products using the resources of the ZKI-tool. In combination with the information layers obtained from aerial imagery, KeepOperational provides traffic analysis and route planning capabilities on infrastructure, affected by a crisis.
Use-cases tested: • Request actual flood information (ZKI). • Add/Remove road obstacles (KeepOperational). • Plan routes (KeepOperational). • Obtain accessibility information (KeepOperational).	
HumLogSim	HumLogSim is an adaptable simulation environment for discrete event-based and agent-based simulations. It represents crisis management activities within and between humanitarian organisations on the way to a defined objective, whilst assessing the overall performance.
Use-cases tested: • Alter evacuation resources and objectives. • Assess evacuation plan. • Provide shift plan.	
3Di	3Di is a cloud-based versatile water manage-ment instrument that enables flood forecas-ting and risk mapping. 3Di models are fast, accurate and visual. 3Di results

<table>
<tr><td></td><td>present flooding locations, water depths, arrival times and damages in high detail. Moreover, flood mitigation measures can be modelled for their effectiveness. Experts and decision-makers can interact with the model to simulate dike breaches, rain events and storm surges.</td></tr>
<tr><td colspan="2">Use-cases tested:
• Make Digital Elevation Map (DEM) alterations.
• Visualize mitigating measures.
• Publish flood map prediction.</td></tr>
<tr><td>SIM-CI</td><td>In short, this solution provides a clear overview of what critical infrastructures (electricity, gas, water, telecom, internet, road, and traffic networks) will be affected in the case of a disruptive event such as a flooding or a cyber-attack. This clear overview is presented in 2D/3D or Virtual Reality and is calculated by combining large amounts of data with scientific models and powerful computing.</td></tr>
<tr><td colspan="2">Use-cases tested:
• Calculate cascading effects.
• Visualize cascading effects.
• Publish critical location with information.</td></tr>
<tr><td>CrisisSuite</td><td>CrisisSuite is a tool that supports the net centric working methods of crisis teams by creating a universal picture of the crisis and shares it horizontally and vertically with all the other teams in the crisis organization. CrisisSuite also assists in maintaining an effective crisis meeting structure and it decreases the administrative workload for the people managing the crisis.</td></tr>
<tr><td colspan="2">Use-cases tested:
• Create/Update logs and situation reports.
• Receive information from CrisisSuite.
• Publish Action Center information to LCMS.</td></tr>
<tr><td>Landelijk Crisis Management Systeem (LCMS)</td><td>LCMS is a nation-wide crisis management system used in The Netherlands to maintain and share a Common Operational Picture supporting large-scale crisis management collaboration. It is a web-based collaboration environment with a very high level of availability. The environment can be used to share information within an organization as well as between organizations. It supports maintaining and sharing geographical as well as textual pictures.</td></tr>
<tr><td colspan="2">Use-cases tested:
• Create/Update crisis information from ROT and Action Centers.
• Obtain flood map layers.
• Receive information from CrisisSuite.
• Publish information to CrisisSuite.</td></tr>
</table>

4.3 Overview of facilitating components and simulators used

Table 4.3: TTI components and simulators used in Trial The Netherlands

TTI component/simulator	Reason for (not) using it
Common Information Space (CIS)	Used to share information between all solutions.
Common Simulation Space (CSS)	Not used, since no solution relied on real-time fictive simulated data that they themselves could not produce or could not be prepared in advance in these solutions. Simulators were used to create pre-scripted simulation data (i.e. ahead of trial run), but this did not require a CSS during the trial run.
TTI adapters	• **Python adapter** for 3Di. • **Java adapter** for HumLogSim, KeepOperational and ZKI. • **REST adapter** for CrisisSuite and SIM-CI. • **JavaScript adapter** for LCMS.
Admin Tool (AT)	Used to technically configure and monitor all connected solutions, components and simulators.
Security	Used to make sure no other than the required applications could connect to the TTI during the Trial run. The security implementation has 2 levels: the authentication of the applications connecting to the TTI, and the authorization of which messages can be received by which application. For this Trial, only the first level was used, making sure that every solution had its own certificate to pass through security and take part in the Trial.
Trial Management Tool (TMT) + Time Service (TS)	Used by the Trial director to create and keep track of the scenario script in a web application. Instead of using a static Excel sheet, this tool allows pre-defined injects to be reminded and handled upon by the Trial staff in an interactive fashion.
Observer Support Tool (OST)	Used by observers to report their observations via checklists during the Trial in a web application. Additional questionnaires were created for all participants to be filled in at the end of each block of this Trial. Since the integration inside the TTI was not realized on time, the OST was deployed as a stand-alone web-application. All data retrieved from the questionnaires and checklists was not stored via the TTI, but had to be retrieved from this stand-alone server.
After Action Review tool (AAR)	Used for real-time monitoring and storage of all data being passed through the TTI.
Large File Service (LFS)	Not needed for this trial, because the large flood maps from 3Di were stored and distributed at the solution.
GeoServer	Under development at the moment of Trial The Netherlands, but not needed by the Trial since 3Di and ZKI provided their own geo server.
3Di	Used to generate a pre-scripted actual flood, which was fed to provide the ZKI-tool with flood masks for the trial. Note that 3Di was also used as solution in the Trial itself, but with slightly different

	data than used to generate this "actual" simulated flood.
XVR Crisis Media (XVR CM)	Used as simulated news broadcasting website as well as for e-mail traffic between the practitioners during the Trial. This allowed the practitioners to e-mail each other on a separate mail channel not alarming other non-participating colleagues about the fictive incident, while also enabling logging via AAR of all e-mails and their timestamps for evaluation purposes.
XVR On Scene (XVR OS)	Used to create visuals (videos and images) of the flooded The Hague, for the two news broadcast videos and news articles provided during the Trial.

4.4 IT architecture and data exchanges

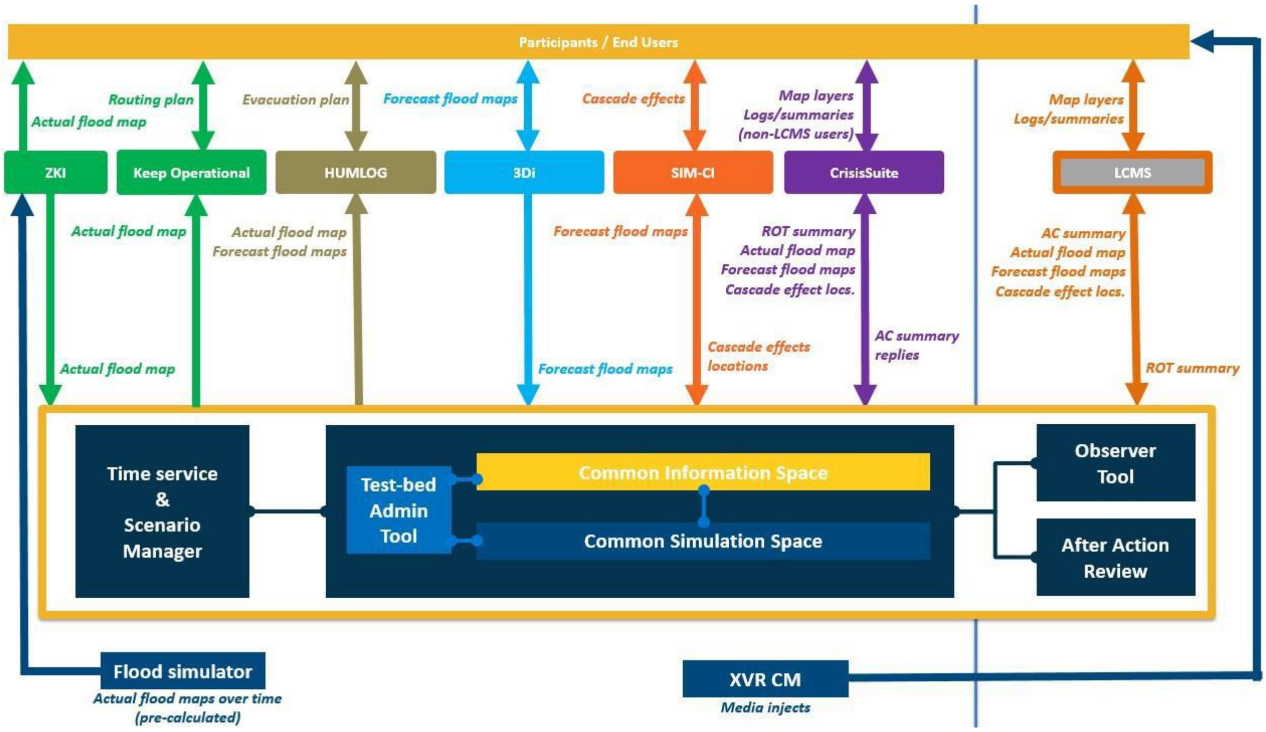

Figure 4.1: Data Exchange Diagram for Trial The Netherlands

The Data Exchange Diagram depicted in Figure 4.1, shows the interconnectivity of all solutions and simulators, and the TTI components, to execute the Trial The Netherlands. Starting from left to right, this section describes each interaction (depicted as arrows) drawn in the Data Exchange Diagram.

In order to have a realistic fictive flooding incident, 3Di was used as a simulator to generate an actual flood map to be used inside the Trial. This flood map was generated before the actual Trial run and was adjusted by the scenario team to incorporate all challenges fitting the assignments for the participants. The generated actual flood map was handed over to ZKI, for it to send this to KeepOperational, HumLogSim, CrisisSuite and LCMS whenever the Trial was entering the flood phase.

Since 3Di is also a solution for predicting the impact of a flooding and its mitigation, this solution was used in the prediction phase of the Trial. The solution was used by participants to forecast the possible flood, given high tide and bad weather conditions. These forecast flood maps were distributed towards HumLogSim, SIM-CI, CrisisSuite and LCMS.

KeepOperational obtained the actual flood map and used this to calculate new routes for emergency services to get in and out of the flooded incident site.

HumLogSim obtained both flood map versions to calculate evacuation strategies and only required these flood maps via the TTI. Other parameters needed to calculate evacuation strategies were to be provided by the participants.

Since SIM-CI calculates cascading effects only based on the predicted flood map, the solution only received this flood map type. In order to support the participants in pinpointing a location in SIM-CI, CrisisSuite and LCMS, SIM-CI was able to send out location information to the other solutions for them to include in their map visualization.

For participants to write complete logs and situation reports, CrisisSuite received practically all data from the other solutions. This solution was used inside the Trial for action centres (specific groups of participants with an expert domain) that do not have access to the LCMS legacy system. A bi-directional communication line was implemented via the TTI between CrisisSuite and LCMS to share information to and from these applications.

Finally, the XVR CM simulator was used to inject certain media posts (like news articles and videos) to the participants. It also provided mail communication between the participants.

The described Data Exchange Diagram has been further specified and implemented as shown in the TTI topic configuration in Figure 4.2. This figure enhances the Data Exchange Diagram by defining which topics (i.e. channels for applications to send and receive messages over) are used and what schema is used for each topic (i.e. the type and format of message to send and/or receive).

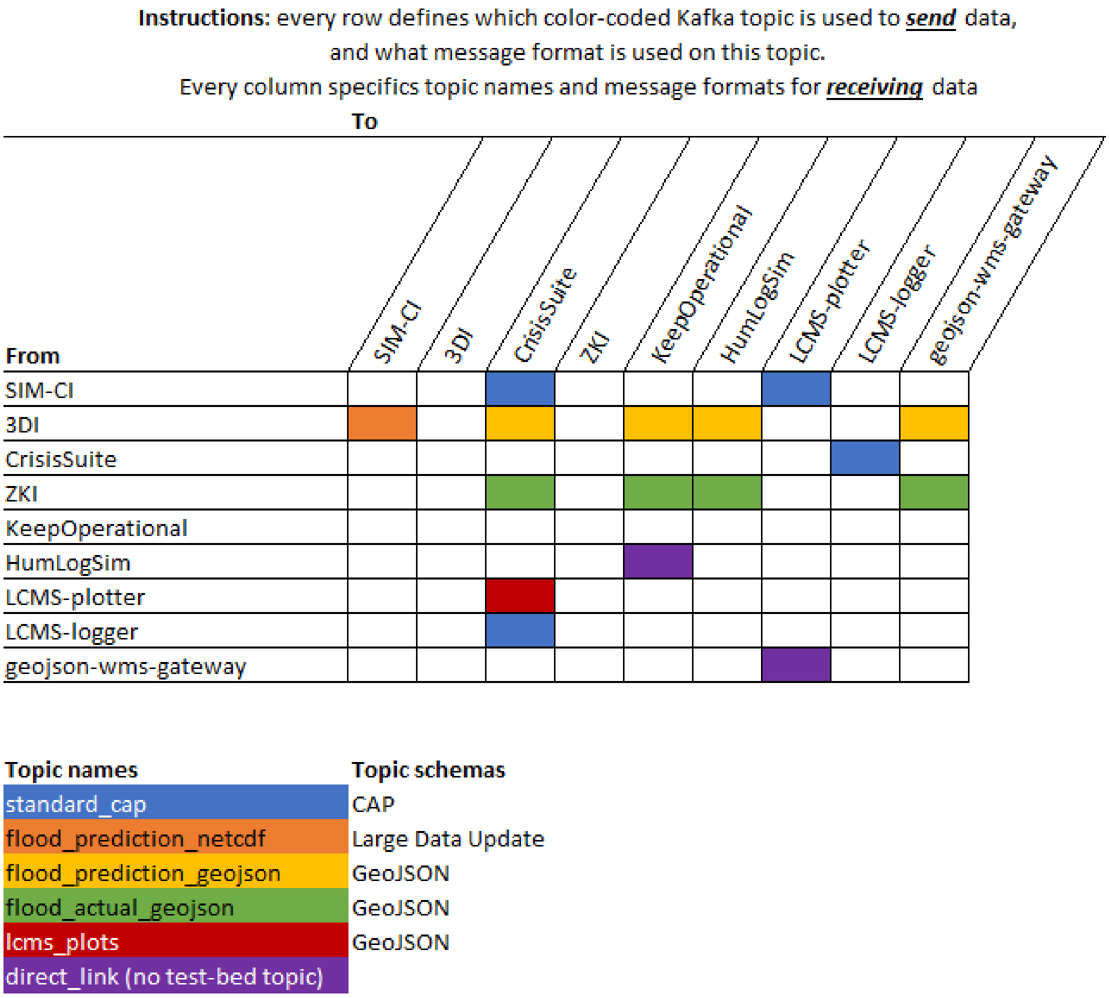

Figure 4.2: TTI topic configuration for Trial The Netherlands

4.5 Lessons identified on the use of the Test-bed Technical Infrastructure

All the required TTI components were present and used extensively during the Trial. The complete TTI was running without any major problems throughout the complete Trial run. The lessons identified in this Trial are listed in Table 4.4.

Table 4.4: Lessons identified in Trial Netherlands

Lesson category	Lesson
Technical	**Provide substantial internet bandwidth and connectivity for an online TTI**
Because the TTI was deployed at an online server, a lot of data interaction between all components, solutions and simulators was sent via the Internet connection and network infrastructure provided by the Platform. During Dry Run 2, the technical staff noticed the amount of bandwidth required to run the Trial was higher than the Platform infrastructure could provide. This primarily led to connection problems at the solutions, having effect on the Trial in general. In order to resolve this issue, before the actual Trial run, the Internet connection at the Platform was upgraded and four LTE modems (providing Internet connection via the mobile phone network) were deployed to off-load the traffic from the existing infrastructure to this network. This resolved the problem found at the Dry Run 2 and the lesson identified is that this should be considered whenever the TTI is being deployed at an online server or when solutions are to be assessed requiring a substantial internet bandwidth.	
Support	**Provide support on the usage of TTI components**
During the TIM and the following Dry Runs, introductory presentations were given regarding the main TTI components (AT, OST, TMT and AAR) to the Trial Committee. However, follow-up on using these components was somewhat lacking behind. Introducing the components needs to be done at the right moment in time; in accordance with the progression level of the Trial Committee member using (results of) those components. While technically most TTI components were connected and stable (OST was stable, but on a stand-alone server not connected to the TTI), a pro-active training, support and guidance is relevant for the user of the component during the Trial. A close communication with the Trial Director or Scenario coordinator and the TMT on one side, and with the Evaluation Coordinator and the OST and AAR on the other, is crucial for understanding the added value of the component and the proper configuration and use within the Trial.	

5. Trial Austria – Earthquake scenario at Pfarrzentrum Münichtal, Eisenerz

Trial Austria was executed in September 2019 (M65) and was the fourth implementation of the DRIVER+ TGM and comprises the complete suite of the TTI.

The Pfarrzentrum Münichtal in Eisenerz was the local platform acting as the Trial Austria testing environment, in which the TTI was deployed. The TTI and its components were deployed locally, although the TTI was also accessible to the Internet to provide a connection with several solutions that could only be used online. This platform was adapted to allow an adequate integration and utilization of the solutions.

At the moment of publishing this deliverable, the Lessons Learned meeting for Trial Austria has not been conducted yet. However, since all other meetings (TIM, Dry Runs and the Trial) were conducted and all had technical debriefing sessions, lessons are already identified on the technical level of the TTI.

In order to properly describe the TTI implementation done for this Trial, subsection 5.1 will briefly explain which lessons identified by previous Trials were implemented. Subsection 5.2 and 5.3 provide an overview of the solutions and facilitating components used for Trial Austria respectively. Subsection 5.4 describes the architecture to connect these solutions and components and what and how data is exchanged. Lessons identified during the Trial are described in subsection 5.5.

5.1 Lessons implemented

Based on the previous Trials in Poland, France and The Netherlands, the lessons listed in Table 5.1 are implemented in the set-up and execution of the Trial Austria.

Table 5.1: Lessons implemented in Trial Austria

Lesson category	**Lesson**
Technical	**Necessity for a Large File Service & GeoServer**
Although the LFS was already created during Trial France, it wasn't necessary to implement for any future Trial. The GeoServer however was implemented and used for Trial Austria.	
Technical	**Necessity for a Python adapter**
The Python adapter was created for Trial The Netherlands, used inside this Trial, and is available for all following Trials.	
Technical	**Perform load tests**
At the end of Dry Run 1 and 2 of Trial Austria, a technical load test was performed to find any degradation problems inside solutions and the platform infrastructure.	
Technical	**Facilitate offline use of the OST**
Because Trial Austria had several field locations without a good internet connection where the OST needed to function, the offline functionality of the OST was implemented and used within this Trial.	
Planning	**Make clear decision on whether or not to use TTI components as early as possible**
During the TIM and Dry Run 1, the TTI components were introduced to the Trial Committee. This helped align the needs of the Trial with the functionalities of the components. All TTI components were used.	
Planning	**Introduce a Trial Integration Meeting**
The TIM in Trial Austria was performed successfully, providing a better understanding for all parties involved in what the Trial entails and how to achieve its goals.	

Support	**Create training material for TTI**
Although the Training Module was still under development, active support and guidance from the DRIVER+ development community was provided to solution providers and platform facilitators.	
Technical	**Test for undesired participant interactions**
From the start of Dry Run 1, additional test cases were introduced to make sure solutions were able to either limit or mitigate undesired user interaction.	
Technical	**Provide a stable storage facility for recording logs relevant for evaluation**
The AAR was implemented and working as intended during this Trial.	
Planning	**Focus on the Data Collection Plan**
The DCP was brought under the attention of all parties that could help with collection of this data. This provided a better understanding of what was important to log.	
Planning	**Explicitly ask solution providers to store their logs after each Trial session**
After each Trial session, the evaluation coordinator made sure all solutions and TTI components had stored their logs.	
Support	**Provide an understanding on what the TTI can do for evaluation purposes**
With the introduction of the TIM, and also during the presentations of the TTI components at the Dry Run 1, the Trial Committee was informed on the possibilities and limitations of the TTI regarding evaluation.	
Technical	**Provide substantial internet bandwidth and connectivity for an online TTI**
Because the platform for Trial Austria did not have any technical infrastructure, the complete setup of cables, routers and internet was provided by the Trial Owner. This included a direct Internet connection with the local Internet Service Provider, resulting in a stable connection for all solutions using this online connection.	

5.2 Overview of solutions, legacy systems and use-cases

Table 5.2: Overview of Solutions assessed and their use-cases in Trial Austria

Solution / legacy system and its use	Short description
Scenario-enabled Psychological First Aid Training (PFA)	The scenario-enabled psychological first aid (PFA) training comprises knowledge on what PFA is, guidelines on how to perform PFA and an experiential training package to build the capacity to deliver quality PFA.
Use-cases tested: • Provide PFA training.	
ASIGN	ASIGN is a solution that helps reduce emergency and disaster response time. It is an optimal all-in-one disaster assessment software tool for the collection, communication and management of operationally relevant information. ASIGN supports the collection and communication of photos, videos, geo-texts, tracks and assessment forms in a very bandwidth efficient manner.
Use-cases tested:	

<table>
<tr><td colspan="2">• Create/Update mission information.
• Obtain volunteer situation reports.
• Publish danger areas.
• Provide satellite communication.
• Publish on scene photo information.</td></tr>
<tr><td>VieWTerra Evolution (VTE)</td><td>VieWTerra Evolution is a 4D Earth Viewer as well as a data & assets integration and development platform. 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 global repository for building a custom Earth-wide GIS, either used perfectly off-line, or ported on an on-line architecture, in order to allow the sharing of information and assets between multiple stakeholders in the crisis response phase.</td></tr>
<tr><td colspan="2">Use-cases tested:
• Visualize high resolution Digital Elevation Map (DEM).
• Visualize data on 3D map environment.
• Measure elevation.</td></tr>
<tr><td>Airborne and Terrestrial Situational Awareness (Airborne)</td><td>The solution “Airborne and Terrestrial Situational Awareness” is composed of several individual components and tools, which are integrated into a complete system, ready to be deployed in different scenarios. DLR's optical 3K camera system is integrated into the research aircraft D-CODE, a modified Dornier Do228 with a digital autopilot, which will be operated as a remotely piloted vehicle (RPV) during the selected trials. The flight path planning and remote control will be executed by the ground control station U-Fly, which is connected to the RPV using a data link for command, control, and communication (C3). The RPV will provide aerial images and send the data over a separate payload data link to the ground system.</td></tr>
<tr><td colspan="2">Use-cases tested:
• Obtain current incident aerial imagery.
• Publish aerial imagery.</td></tr>
<tr><td>CrowdTasker</td><td>CrowdTasker enables crisis managers to instruct large numbers of non-institutional (either spontaneous or pre-registered) volunteers with customizable tasks, contextual information, warnings and alerts, as well as to crowdsource information from them. The received feedback is evaluated and visualized and provides crisis managers with a detailed overview of the situation, which is used in turn to trigger adequate disaster relief services.</td></tr>
<tr><td colspan="2">Use-cases tested:
• Manage volunteer tasks and reports.
• Send tasks to volunteers.
• Obtain volunteer results.
• Publish volunteers’ reports.</td></tr>
</table>

5.3 Overview of facilitating components and simulators used

Table 5.3: TTI components and simulators used in Trial Austria

TTI component/simulator	Reason for (not) using it
Common Information Space (CIS)	Used to share information between all solutions.
Common Simulation Space (CSS)	Not needed for this Trial, since no solution relied on fictive simulated data.
TTI adapters	• **Python adapter** for ASIGN. • **REST adapter** for VTE, Airborne and CrowdTasker.
Admin Tool (AT)	Used to technically configure and monitor all connected solutions, components and simulators.
Security	Not needed for this Trial, since this was a local deployment of the TTI at the secured platform.
Trial Management Tool (TMT) + Time Service (TS)	Used by the Trial staff to create and keep track of the scenario script in a web application. Instead of using a static Excel sheet, this tool allows pre-defined injects to be reminded and handled upon by the Trial staff in an interactive fashion.
Observer Support Tool (OST)	Used by observers to report their observations via checklists during the Trial in a web application. Additional questionnaires were created for all participants to be filled in at the end of this Trial. Because parts of this Trial were done in the field with limited network connection, the OST also used its offline feature (storing observations on the tablet, to be sent out whenever a network connection is made).
After Action Review tool (AAR)	Used for real-time monitoring and storage of all data being passed through the TTI.
Large File Service (LFS)	Not needed for this Trial, because the large imagery map from Airborne was stored, translated and distributed at the GeoServer.
GeoServer	Used for translating the output data from Airborne to a format (WMS) that is readable by VTE.

5.4 IT architecture and data exchanges

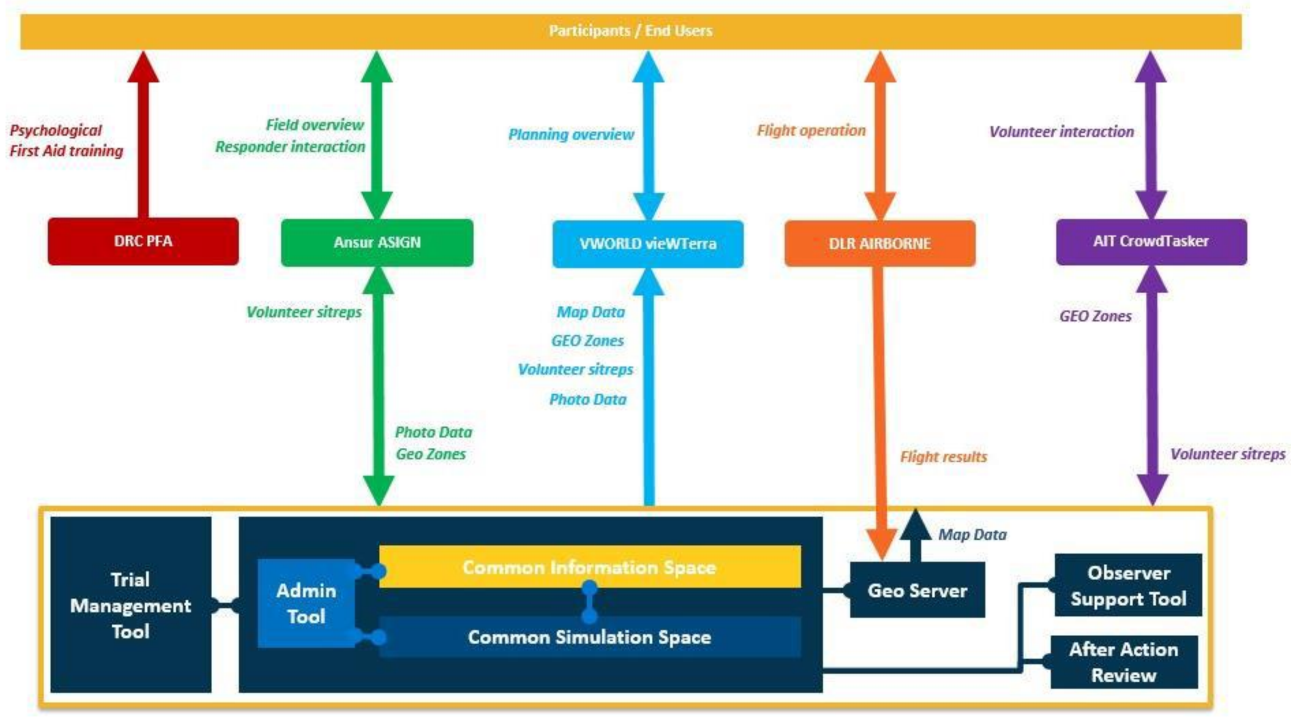

Figure 5.1: Data Exchange Diagram for Trial Austria

The Data Exchange Diagram depicted in Figure 5.1, shows the interconnectivity of all solutions and simulators, and the TTI components, to execute the Trial Austria. Starting from left to right, this section describes each interaction (depicted as arrows) drawn in the Data Exchange Diagram.

PFA, being a training module to be tested during this Trial, did not have a technical component to be connected to the TTI. However, the OST was used to record observations of the use of PFA.

The ASIGN solution was used for decision support by allowing participants to draw danger areas to be avoided by the volunteers managed in CrowdTasker. CrowdTasker in its turn reported its volunteer situation reports to ASIGN, to provide an overview also shown in ASIGN. ASIGN also provided photo data messages from a field unit to higher command to get detailed information about a specific incident.

VTE received relevant messages from all the connected solutions to visualize this data on a 3D virtual map of the incident.

To retrieve an accurate picture of the incident site, Airborne was used to fly a plane across the area and send out these flight results to VTE, via the GeoServer which translated this data into an accepted input format of VTE.

The described Data Exchange Diagram has been further specified and implemented as shown in the TTI topic configuration in Figure 5.2. This figure enhances the Data Exchange Diagram by defining which topics (i.e. channels for applications to send and receive messages over) are used and what schema is used for each topic (i.e. the type and format of message to send and/or receive).

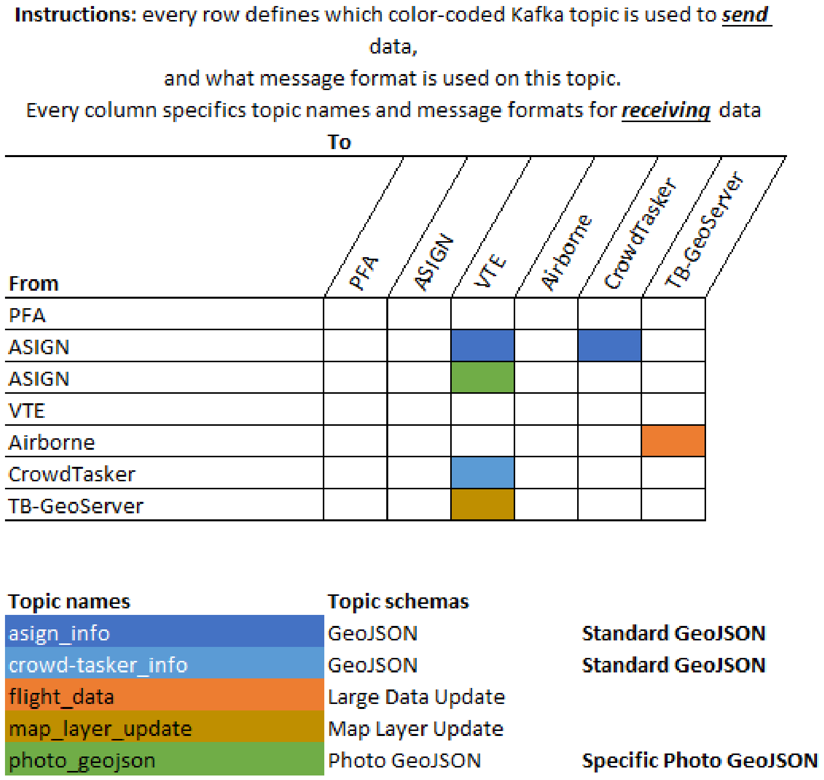

Figure 5.2: TTI topic configuration for Trial Austria

5.5 Lessons identified on the use of the Test-bed Technical Infrastructure

All the required TTI components were present and used extensively during the Trial. The complete TTI was running without any major problems throughout the complete Trial run. The lessons identified in this Trial are listed in Table 5.4.

Table 5.4: Lessons identified in Trial Austria

Lesson category	Lesson
Technical	**Include TTI components inside load tests**
Trial Austria had the premiere of using the GeoServer TTI component. Although the GeoServer was included inside the tests for Dry Run 1 and Dry Run 2, an increase of data to process was encountered at the Trial. While the test data during the Dry Runs were proving no problem to the GeoServer, the data obtained during the Trial provided performance issues at this component. The lesson identified here is to also include the GeoServer in the load test at the Dry Runs, making sure this component can be tested with a larger dataset than expected during the Trial.	
Planning	**Resolve planning congestions in the use of TTI components as soon as possible**
Trial Austria marked the first implementation of the OST running inside the TTI, connected to the TTI, making it possible to record the answers on the observer checklists inside the AAR directly. Because of parts of the Trial being performed outside the platform, including areas where the Internet connection was absent, OST also made use of the offline implementation. This allowed observer answers to be stored locally on the tablet whenever the connection was lost to the OST, sending the answers as soon as connection was restored. Because of a fast change of Trial session locations, and observers being scheduled to multiple consecutive sessions, several logistical issues arose. This mainly had to do with preparing the OST checklists for the observers to be transferred to the field in the next session while the current session was still running. Either taking into account the time of preparing the OST during the Trial	

or having more tablets present would have resolved this logistical issue.	
Support	**Provide support on the usage of TTI components**
During Trial The Netherlands, a closer support and guidance in using the TTI components had been identified as a lesson. During Trial Austria the involvement of the TTI components (AT, OST, TMT and AAR and the newly used GeoServer) was evermore increasing. However, this lesson remains valid for Trial Austria as well.	

6. Final Demo – Wildfire scenario at SGSP and SRC, Warsaw & Safety Region The Hague, The Hague

The Final Demo, which will be executed in November 2019 (M67) is the last Trial event within the DRIVER+ project and will use the complete suite of the Test-bed Technical Infrastructure (TTI). The Final Demo scenario includes a fictive crisis to be managed at multiple physical locations in two different countries at which the Final Demo is to be run; the Platform for the Final Demo testing environment is therefore split up into multiple locations. The main Platform location is the Main School of Fire Service – SGSP in Warsaw, with two additional locations being the Space Research Centre (SRC PAS), Warsaw in Poland and the Safety Region The Hague, The Hague in The Netherlands.

The TTI will be deployed on an online server, to be monitored by technical experts from the SGSP location. The reason for deploying the TTI and all its components online is to facilitate the use of the TTI components that are used at all Platform locations (i.e. OST, TMT, the solution CrisisSuite and the simulator XVR Crisis Media).

Note that when submitting this deliverable (M66), the Final Demo still needs to be performed (M67). Dry Run 2 is already successfully completed though, so the technical set-up is envisioned not (or only marginally) to change in the meantime.

In order to properly describe the TTI implementation done for the Final Demo, subsection 6.1 will briefly explain which lessons identified by previous Trials have been implemented or are going to be implemented. Subsection 6.2 and 6.3 provide an overview of the solutions and facilitating components used for the Final Demo respectively. Subsection 6.4 describes the architecture to connect these solutions and components and what and how data is exchanged. Lessons identified during the Trial are described in subsection 6.5.

6.1 Lessons implemented

Based on the previous Trials, the lessons listed in Table 6.1 are already implemented or will soon be implemented in the set-up and execution of the Final Demo.

Table 6.1: Lessons (to be) implemented in the Final Demo

Lesson category	Lesson
Technical	**Necessity for a Large File Service & GeoServer**
Although the LFS was already created during Trial France, it wasn't necessary to implement for any future Trial. The GeoServer however was implemented and used for the Final Demo.	
Technical	**Necessity for a Python adapter**
The Python adapter was created and used inside the Final Demo.	
Technical	**Perform load tests**
At the end of Dry Run 1 and 2 of the Final Demo, a technical load test was performed to find any degradation problems inside solutions and the platform infrastructure.	
Planning	**Make clear decision on whether or not to use TTI components as early as possible**
During the TIM and Dry Run 1, the TTI components were introduced to the Trial Committee. This helped align the needs of the Trial with the functionalities of the components. All TTI components are going to be used.	
Planning	**Introduce a Trial Integration Meeting**
The TIM for the Final Demo was performed successfully, providing a better understanding for all parties	

<table>
<tr><td colspan="2">involved in what the Trial entails and how to achieve its goals.</td></tr>
<tr><td>Support</td><td>Create training material for TTI</td></tr>
<tr><td colspan="2">Although the Training Module was still under development, active support and guidance from the DRIVER+ development community was provided to solution providers and platform facilitators.</td></tr>
<tr><td>Technical</td><td>Test for undesired participant interactions</td></tr>
<tr><td colspan="2">From the start of Dry Run 1, additional test cases were introduced to make sure solutions were able to either limit or mitigate undesired user interaction.</td></tr>
<tr><td>Technical</td><td>Provide a stable storage facility for recording logs relevant for evaluation</td></tr>
<tr><td colspan="2">The AAR was implemented and working as intended during this Trial.</td></tr>
<tr><td>Planning</td><td>Focus on the Data Collection Plan</td></tr>
<tr><td colspan="2">The DCP was brought under the attention of all parties that could help with collection of this data. This provided a better understanding of what was important to log.</td></tr>
<tr><td>Planning</td><td>Explicitly ask solution providers to store their logs after each Trial session</td></tr>
<tr><td colspan="2">After each Final Demo session, the evaluation coordinator made sure all solutions and TTI components had stored their logs.</td></tr>
<tr><td>Support</td><td>Provide an understanding on what the TTI can do for evaluation purposes</td></tr>
<tr><td colspan="2">With the introduction of the TIM, and also during the presentations of the TTI components at the Dry Run 1, the Trial Committee was informed on the possibilities and limitations of the TTI regarding evaluation.</td></tr>
<tr><td>Technical</td><td>Provide substantial internet bandwidth and connectivity for an online TTI</td></tr>
<tr><td colspan="2">Being used at multiple platform locations, the TTI is deployed online for the Final Demo. Since the most Internet connectivity is required at the SGSP location, additional measures (like back-up LTE modems) are taking into account to provide a stable connection with the online TTI.</td></tr>
<tr><td>Technical</td><td>Include TTI components inside load tests</td></tr>
<tr><td colspan="2">During the load tests of the Final Demo, the TTI components were also connected and tested for any performance or degradation issues.</td></tr>
<tr><td>Support</td><td>Provide support on the usage of TTI components</td></tr>
<tr><td colspan="2">All TTI components were introduced and are going to be used by the respective coordinators of the Final Demo. An active support and guidance is done by the development partners to help the coordinators in using the TTI components themselves.</td></tr>
</table>

6.2 Overview of solutions, legacy systems and use-cases

Table 6.2: Overview of Solutions that will be assessed and their use-cases in Final Demo

Solution / legacy system and its use	Short description
CrisisSuite	CrisisSuite is a tool that supports the net centric working methods of crisis teams by creating a universal picture of the crisis and shares it horizontally and vertically with all the other teams in the crisis organisation. CrisisSuite also assists in maintaining an effective crisis meeting structure and it decreases the administrative workload for the people managing the crisis.

<table>
<tr><td colspan="2">Use-cases tested:
• Create/Update logs and situation reports.
• Obtain information relevant for reports via other users of CrisisSuite and from legacy systems (i.e. e-mail and phone).
• Receive and visualize geo-information.
• Publish logs and situation reports to other users of CrisisSuite.</td></tr>
<tr><td>SOCRATES OC (SOC)</td><td>SOCRATES OC enhances analysis and decision-making capabilities by means of an improved shared situational awareness based on relevant information about the operational situation including crisis events, missions and resources. The information is created by the operator or coming from external sources. The information is displayed on a Common Operational Picture (COP).</td></tr>
<tr><td colspan="2">Use-cases tested:
• Visualize Common Operational Picture (COP).
• Publish incident updates (mission, resources, Base of Operations (BoO).</td></tr>
<tr><td>VieWTerra Evolution (VTE)</td><td>VieWTerra Evolution is a 4D Earth Viewer as well as a data & assets integration and development platform. 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 global repository for building a custom Earth-wide GIS, either used perfectly off-line, or ported on an on-line architecture, in order to allow the sharing of information and assets between multiple stakeholders in the crisis response phase.</td></tr>
<tr><td colspan="2">Use-cases tested:
• Visualize high resolution Digital Elevation Map (DEM).
• Receive and visualize drone imagery data on 3D map environment.
• Receive and visualize geo-tagged photos on 3D map environment.
• Geo-information from legacy system Copernicus.
• Measure elevation.</td></tr>
<tr><td>Drone Rapid Mapping (DRM)</td><td>Drone Rapid Mapping enables rapid mapping of incident/crisis area. The solution enables very fast generation of orthophoto maps based on imagery acquired by any drone (RPAS) available to rescue or crisis management actors. The resulting maps can be viewed and analysed in the dedicated geoportal or any GIS environment already utilized by crisis management institutions. The additional product is a 3D terrain model, enabling better and more intuitive understanding of the area of interest.</td></tr>
<tr><td colspan="2">Use-cases tested:
• Publish incident drone imagery.</td></tr>
<tr><td>Field Reporting Tool (FRT)</td><td>Field Reporting Tool provides the ability to share field reporting information such as photos and reports (e.g. damage report, needs assessment). It supports the analysis of the Base of Operations by sending geo-located reports and pictures of the terrain to obtain a better view of the situation on the ground.</td></tr>
<tr><td colspan="2">Use-cases tested:
• Obtain photos by capturing them from XVR On Scene display.
• Publish geo-tagged photos.</td></tr>
</table>

6.3 Overview of facilitating components and simulators used

Table 6.3: TTI components and simulators that will be used in Final Demo

TTI component/simulator	Reason for (not) using it
Common Information Space (CIS)	Used to share information between all solutions.
Common Simulation Space (CSS)	Used to connect the XVR CM simulator to send log data to the TTI.
TTI adapters	• **Python adapter** for DRM. • **Java adapter** for SOC. • **REST adapter** for VTE, CrisisSuite, and FRT. • **C# adapter** for XVR CM.
Admin Tool (AT)	Used to technically configure and monitor all connected solutions, components and simulators.
Security	Used to make sure no other than the required applications could connect to the TTI during the Trial run. For this final demo, only the authentication of the applications connecting to the TTI was used, making sure that every solution had its own certificate to pass through security and take part in the Trial.
Trial Management Tool (TMT) + Time Service (TS)	Used by the Trial staff to create and keep track of the scenario script in a web application. Instead of using a static Excel sheet, this tool allows pre-defined injects to be reminded and handled upon by the Trial staff in an interactive fashion.
Observer Support Tool (OST)	Used by observers to report their observations via questionnaires during the Trial in a web application. Additional questionnaires were created for practitioners and solution providers to be filled in at the end of this Trial.
After Action Review tool (AAR)	Used for real-time monitoring and storage of all data being passed through the TTI.
Large File Service (LFS)	Used for storing all mail attachments created inside the XVR CM simulator for evaluation purposes.
GeoServer	Used for outputting data provided by Copernicus and EFFIS EU applications.
XVR Crisis Media (XVR CM)	Used to simulate news broadcasting websites as well as for e-mail traffic (i.e. legacy communication system) between the practitioners during the Trial. This allows the practitioners to e-mail each other on a separate mail channel not alarming other non-participating colleagues about the fictive incident. Furthermore, a link between TMT and XVR CM is established such that several prepared media posts and e-mails can be automatically made available by the Trial staff. Having XVR CM linked to the TTI, also enables for evaluation purposes the logging via AAR of all e-mails and media posts and their timestamps.
XVR On Scene (XVR OS)	Used to provide 3D visuals of the incident scenes and wildfire front in case participants (i.e. EUCPT or Module commanders) want to visit these for liaising with host local commanders. The standard product-version of XVR OS at time of the Final Demo

	(i.e. XVR OS 2019 SP1) will be used because of stability and extensive operator experience with this version. This version is not linked to the TTI. No coupling is needed because 3D visual simulation data is not required by one of the solutions and therefor also no XVR OS data will be send over the TTI and thus there is no XVR OS data available to be logged by AAR.

6.4 IT architecture and data exchanges

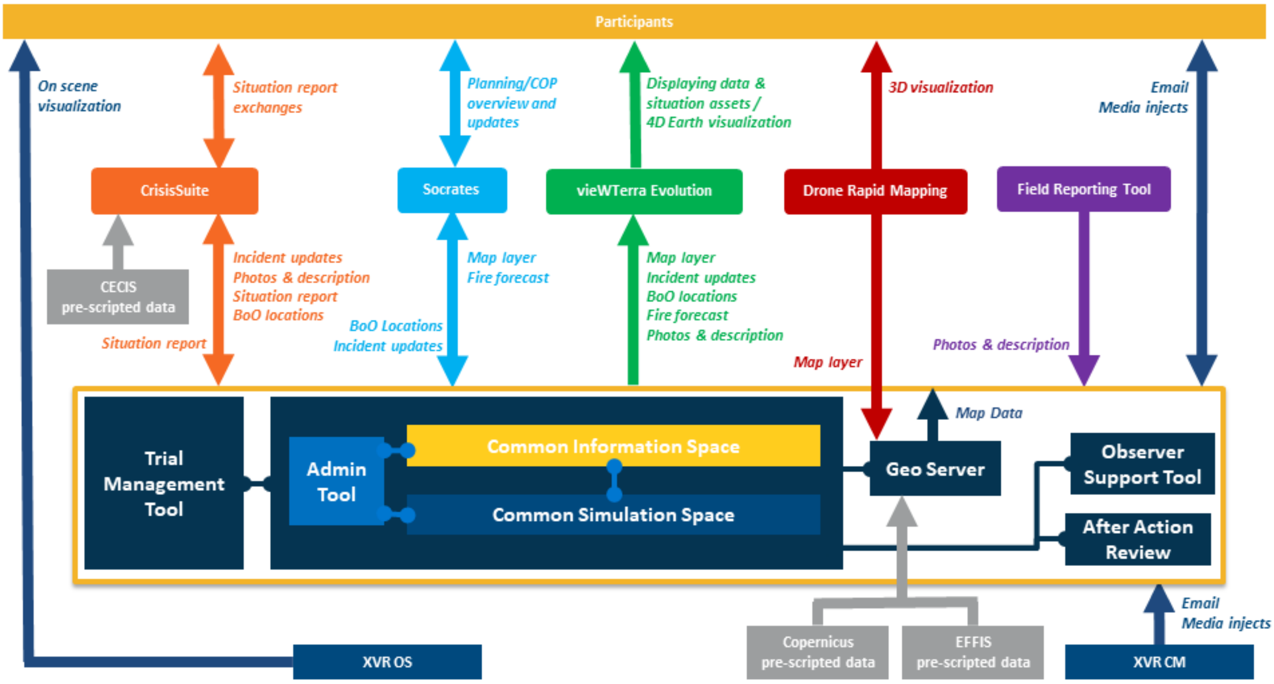

Figure 6.1: Data Exchange Diagram for Final Demo

The Data Exchange Diagram depicted in Figure 6.1, shows the interconnectivity of all solutions and simulators, and the TTI components, to execute the Final Demo. Starting from left to right, this section describes each interaction (depicted as arrows) drawn in the Data Exchange Diagram.

First, a lot of pre-generated data was needed for the Final Demo. The CECIS data (represented in PDF documents), Copernicus data (in GeoTIFF format) and EFFIS data (represented in shape-files) were all pre-scripted and supplied before the Final Demo run. The CECIS data could be directly uploaded to CrisisSuite, while the other two formats were loaded in the GeoServer, to be distributed to the solutions at a given moment during the Final Demo.

CrisisSuite also receives messages from SOC and FRT for participants to include this information in their reports and logs during the Final Demo. Since both CrisisSuite is used by three different hierarchies of participants (i.e. ERCC, EUCPT and Modules) and SOC being used by two different hierarchies of participants (i.e. EUCPT and Modules), SOC has the option to send geo-information to CrisisSuite, informing it which users need to see this data. CrisisSuite itself also has this option implemented sending out situation reports via the TTI towards itself, to notify the solution for which users the report is meant.

Being a COP tool, SOC receives all map layer data from both GeoServer and the DRM solution. All mission and resource information created and updated by the SOC users will be shared to CrisisSuite and VTE.

VTE will receive all messages from SOC, DRM, FRT and GeoServer to visualize this data inside its 3D virtual environment.

Both DRM and FRT all provide information towards the TTI. DRM map information will be received by VTE and SOC, while FRT geo-tagged photos will be received by VTE and CrisisSuite, all to be visualized to the participants using those solutions.

XVR CM and XVR OS are used as simulators during the Final Demo. XVR OS is used for visualization purposes, allowing participants to observe the fictive wildfire incident scenes during the Final Demo run. XVR CM is used as legacy system to simulate news and social media footage for the participants, injected by the Trial staff whenever needed. XVR CM also provides mail communication between the participants.

The described Data Exchange Diagram has been further specified and implemented as shown in the TTI topic configuration in Figure 6.2. This figure enhances the Data Exchange Diagram by defining which topics (i.e. channels for applications to send and receive messages over) are used and what schema is used for each topic (i.e. the type and format of message to send and/or receive).

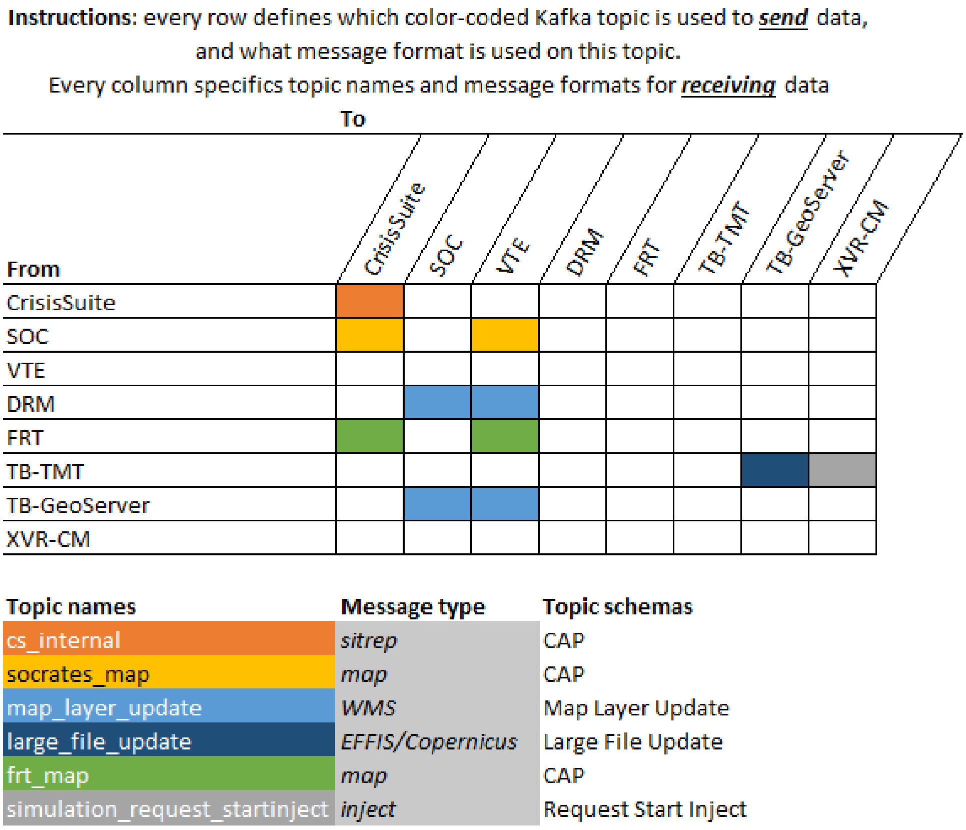

Figure 6.2: TTI topic configuration for Final Demo

6.5 Lessons identified on the use of the Test-bed Technical Infrastructure

Since the Final Demo still needs to be executed when submitting this deliverable, no lessons on the use of the TTI during the execution of the Final Demo itself can be identified yet. These lessons are expected to be described in deliverable **D947.12 *Report on Trial Evaluation – Final demo*** (10). However, TIM, Dry Run 1 and Dry Run 2 were executed, and already identified one lesson on the use of the TTI, as described in Table 6.4.

Table 6.4: Lessons identified in preparations of the Final Demo

Lesson category	Lesson
Support	**Make sure progress is maintained with all perspectives of a Trial**
Although a TIM, Dry Run 1 and Dry Run 2 were executed in support of focusing all perspectives on the development to be done, unforeseen delays like moving a complete physical location from Italy to Poland and The Netherlands by circumstances beyond control were preventing the scenario to be progressed further. Although no major technical difficulties or issues were caused by this delay, this issue stresses the point that scenario, evaluation, technical and logistical perspectives preparing a Trial are co-dependant on each other for implementing a proper Trial. Without progress on all perspectives, the preparation and development phases can stall, causing time pressure on everyone involved.	

7. Conclusion and way forward

The main aim of the TTI and all its components is to facilitate high-quality and user-friendly preparation, execution and evaluation of Trials and similar events (e.g. the Final Demo or an exercise). Implementing the TTI and using the components during the DRIVER+ Trials led to a large amount of experience and generated many ideas how to use these components better, more diversely or in different ways. The developers responsible for the creation of the components further developed them and tailored them to the more generic needs and objectives for facilitating Trials.

By using the TTI and its components during four Trials and the Final Demo (i.e. yet to be executed and evaluated), a total of 17 lessons were identified. 15 of those lessons could be implemented in later Trials thanks to the iterative nature of the project. During the Trials and the Final Demo, a diverse range of deployments of the TTI and its components were implemented. This tailoring proved to be effective and components were found very helpful in preparing, executing and evaluating a Trial. Practically every Trial resulted in new insights and improvements that could be taken up and evaluated in later Trials, as can be seen in the changelogs of the individual GitHub repositories. (14)

Despite certain TTI components not being available at the first Trials, the core framework implementation of the TTI did not cause major problems to any of these Trials. Even though lessons identified in Trial Poland and Trial France discuss the need for TTI components and/or component functionality that unfortunately could not be implemented on time for these Trials, the already implemented and used versions of TTI components in these Trials were not causing any issues reported as lessons identified.

The installation and deployment of the TTI is easy to implement, clear documentation is provided and a (technical) community exists to support and maintain the TTI during the DRIVER+ project. All solution and simulator providers managed to implement a connection with the TTI within the limited timeframe between being selected for the Trial and the Dry Run 1. Support of this integration process was needed and provided by the TTI community via online documentation, TIMs, mails and the DRIVER-EU Slack channel. Although after the DRIVER+ project the current community might dissolve, the online documentation and training material provided in the Training Module will remain (for detailed information about the Training Module and the TTI materials being provided there, refer to **D924.12 *Materials for the Training Module 2*** (15)). This allows future software developers and IT technicians to easily install, deploy and connect to the current implementation of the TTI. It also allows for incorporations of new TTI components and component functionality, if the need is there. The TTI source code being made publicly available under open source MIT license enables future developers to also maintain and adjust the current TTI components, and (potentially) share these alterations (e.g. improvements) with the online community.

Although these findings indicate the framework and core implementation of the TTI and its components are well-defined and can be well-implemented for Trials and similar events, specific content-related attention is still required on an event-by-event basis. Every Trial organized had its own setting (both technically as well as all other perspectives) and provided for the TTI development team different perspectives (including ideas and opinions from externals). The TTI's development and implementation process as followed in the project, allowed to focus on the core features of the TTI, creating a generic framework to be used in many different settings. At the same time, it also provided its own challenges regarding implementation of TTI components, as also shown by the specific implementations described in this document. A close interaction between the teams working for a specific Trial on the scenario, evaluation, solutions and simulators, platform infrastructure and TTI proved to be essential in deploying a TTI that serves and supports the needs of that Trial. Training material and support by a development- and deployment-community is essential to implement the TTI into future Trials and similar events.

Taking in account this essential close interaction, more than 50% of the lessons identified found during the Trial-specific TTI implementations were not of a technical nature. Many had to do with defining and following processes, procedures and communication lines to help all parties involved to reach the common goal of successfully executing and evaluating a Trial. The lesson that led to the introduction of the TIM inside the TGM was quickly identified, adequately recognized and picked up. Nevertheless, although the TIM showed to be a very useful face-to-face meeting, further lessons still stress the point of understanding that all perspectives involved in a Trial are co-dependant on each other. From a technical perspective, understanding the scenario and evaluation domain, requirements and wishes helps to focus the technical implementation on those requirements and wishes. A first technical run-through in Dry Run 1, can then help all other perspectives in understanding the possibilities and (technical) limitations with concrete showcases, thereby steadily helping each other in achieving a properly designed and executed Trial.

In order to use the TTI for future Trials and similar events, the training material, developer documentation and source code is suitable. Because the source code is provided open source and thus in principle free-of-charge on GitHub (14), it is also envisioned financially feasible for targeted users, like governmental crisis management organisations and research institutes, to use it. The obtained knowledge - described in this deliverable as lessons identified - is a good source for setting up and using the TTI more efficiently. The documentation inside the project's GitBook (13) and GitHub repositories (14) might be expanded into a knowledge base for and by developers and users of the TTI (e.g. by starting up a dedicated CMINE group). This knowledge base should help in supporting future developers and users setting up the TTI inside new Trials, exercises and/or experiments, and to those who want to connect multiple software applications to share data.

All in all, the current implementation of the TTI proves to be a stable and helpful implementation for the purpose of performing Trials. Future use of the TTI framework and components seems very much possible, even broadening the scope of supporting Trials towards support as well of other type of experiments, exercises or assessments. Although specific configurations for particular requirements are most likely unavoidable, the current implementation provides a stable framework that can relatively easily be maintained and improved upon by future developers and IT deployment specialists.

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Annexes

Annex 1 – DRIVER+ Terminology

In order to have a common understanding within the DRIVER+ project and beyond and to ensure the use of a common language in all project deliverables and communications, a terminology is developed by making reference to main sources, such as ISO standards and UNISDR. This terminology is presented online as part of the Portfolio of Solutions and it will be continuously reviewed and updated[1]. The terminology is applied throughout the documents produced by DRIVER+. Each deliverable includes an annex as provided here-under, which holds an extract from the comprehensive terminology containing the relevant DRIVER+ terms for this respective document.

Table A1: DRIVER+ Terminology

Terminology	Definition	Source
Test-bed Technical Infrastructure	The software tools and middleware to systematically create an appropriate (life and/or virtual) environment in which the trialling of solutions is carried out. The Test-bed infrastructure can enable existing facilities to connect and exchange data.	Initial DRIVER+ definition.
Trial	An event for systematically assessing solutions for current and emerging needs in such a way that practitioners can do this following a pragmatic and systematic approach.	Initial DRIVER+ definition.
Test-bed	The software tools, middleware and methodology to systematically conduct Trials and evaluate solutions within an appropriate environment. An “appropriate environment” is a testing environment (life and/or virtual) where the trialling of solutions is carried out using a structured, all-encompassing and mutual learning approach. The Test-bed can enable existing facilities to connect and exchange data, providing a pan-European arena of virtually connected facilities and crisis labs where users, providers, researchers, policy makers and citizens jointly and iteratively can progress on new approaches or solutions to emerging needs.	Initial DRIVER+ definition.
Solution	A solution is a means that contributes to a crisis management function. A solution is either one or more processes or one or more tools with related procedures.	Initial DRIVER+ definition.

[1] The Portfolio of Solutions and the terminology of the DRIVER+ project are accessible on the DRIVER+ public website (https://www.driver-project.eu/). Further information can be received by contacting coordination@projectdriver.eu.

Tool	A device, equipment or piece of software used to carry out a particular process or procedure.	Initial DRIVER+ definition.
Best Practice	This encompasses the preferred actions in a specific type of situation to efficiently and effectively achieve a certain objective. Best Practice may be formalised in internal policy documents such as handbooks and standard operation procedures and could be based on one or several Lesson Identified/Lessons Learned approved by decision-makers.	Initial DRIVER+ definition.
Interoperability	The ability of diverse systems and organisations to work together, i.e. to interoperate.	"ISO 22397:2014(en) Societal security — Guidelines for establishing partnering arrangements."
Lessons Learning process	Distributing the problem information to the whole project and organization as well as other related projects and organizations, warning if similar failure modes or mechanism issues exist and taking preventive actions.	"Adapted from ISO 18238:2015(en) Space systems — Closed loop problem solving management, 3.3."
Evaluation	Process of estimating the effectiveness, efficiency, utility and relevance of a service or facility.	"ISO 5127:2017(en) Information and documen-tation — Foundation and vocabulary, 3.1.3.02."
Innovation	"Implementation of a new or significantly improved product (good or service), or process, new marketing method, or new organizational method in business practices, workplace organization or external relations. ISO 37500:2014(en) Guidance on outsourcing, section 3.6: new or changed object (3.6.1) realizing or redistributing value."	"ISO 9000:2015(en) Quality management systems — Fundamentals and vocabulary, 3.6.15."