Driving Innovation in Crisis Management for ***E***uropean ***R***esilience

D22.21 - DRIVER Test-bed: Simulation models for Experiment Support

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List of Acronyms

Abbreviation / acronym	Description
AI	Artificial Intelligence
CBRN	Chemical, Biological, Radiological and Nuclear
CM	Crisis Management
GIS	Geographical Information System
MUT	Model Urban Terrain
TRL	Technology Readiness Level

Project Description

DRIVER evaluates solutions in three key areas: civil society resilience, responder coordination as well as training and learning.

These solutions are evaluated using the DRIVER test-bed. Besides cost-effectiveness, DRIVER also considers societal impact and related regulatory frameworks and procedures. Evaluation results will be summarised in a roadmap for innovation in crisis management and societal resilience.

Finally, looking forward beyond the lifetime of the project, the benefits of DRIVER will materialize in enhanced crisis management practices, efficiency and through the DRIVER-promoted connection of existing networks.

DRIVER Step #1: Evaluation Framework

- Developing test-bed infrastructure and methodology to test and evaluate novel solutions, during the project and beyond. It provides guidelines on how to plan and perform experiments, as well as a framework for evaluation.
- Analysing regulatory frameworks and procedures relevant for the implementation of DRIVER-tested solutions including standardisation.
- Developing methodology for fostering societal values and avoiding negative side-effects to society as a whole from crisis management and societal resilience solutions.

DRIVER Step #2: Compiling and evaluating solutions

- Strengthening crisis communication and facilitating community engagement and self-organisation.
- Evaluating solutions for professional responders with a focus on improving the coordination of the response effort.
- Benefiting professionals across borders by sharing learning solutions, lessons learned and competencies.

DRIVER Step #3: Large scale experiments and demonstration

- Execution of large-scale experiments to integrate and evaluate crisis management solutions.
- Demonstrating improvements in enhanced crisis management practices and resilience through the DRIVER experiments.

DRIVER is a 54 month duration project co-funded by the European Commission Seventh Framework Programme (FP7/2007-2013) under grant agreement no. 607798.

Executive Summary

One of the key DRIVER objectives aims at providing a Test-bed for experimentation of new crisis management concepts, using live, virtual and constructive simulation. Different existing tools allow simulating crisis on various granularity levels, in various situations and crisis phases. Hence, some of these tools complete themselves, while others bring different ways to simulate the same crisis contexts. The goal of the Task 22.2 has become to establish a catalogue for choosing the most adapted sets of simulation models and tools (simulation and orchestration tools from Task 22.1) for the different Test-bed experiments. Therefore, it consists of describing the scope of the available simulation tools: identifying and describing them, and studying their contributions on various criteria. It leads to an overall perception of these tools and brings their coverage over crisis management.

For this purpose, the contribution of this task can be divided in three steps:

1. The establishment of a questionnaire to efficiently gather relevant information on each tool.
2. The establishment of simulation models based on the choice of simulations tools for each experiment.
3. The implementation of an online catalogue DRIVER-CAT to propose a user-friendly interface, so that the users can easily have a global view on the simulation models and tools and chose the most adapted to specific crisis context and situations (e.g. different Test-bed experimentation activities).

The designed questionnaire allows gathering information on the tools, to identify their functionalities, their users, the input needed (based on business and technical point of view), the output provided, their Technology Readiness Level and their price. This questionnaire was spread over the DRIVER partners, who fulfilled it for tools owned by Driver Partners and also tools owned by other company. For now, 46 tools were investigated (23 tools owned by Driver Partner, 23 tools owned by other company).

The Task aims at classifying the tools on three top-level criteria: their price, their functionalities and the situations (e.g. road traffic, hospital management, etc.) they are able to simulate or functionalities they are able to provide.

Faced with the high amount of collected information on these tools, the difficulty to share it over all the partners and the necessity to be able to classify the tools (to choose the adapted tools for the Test-bed experiments), a website has been set up thanks to an open source Content Management System. This DRIVER-CAT website especially brings an efficient browsing experience when searching for adapted tools.

1 Introduction

1.1 Position of this work in DRIVER Project

Within the DRIVER project, the DRIVER Test-bed aims at evaluating emerging solutions in three key areas: civil society resilience, responder coordination as well as training and learning. In order to achieve this objective, the DRIVER Test-bed has to provide methods and tools for scenario generation, development of metrics, data collection and evaluation as shown by Figure 1: Technical infrastructure of the Test-bed.

This support is mainly divided into two aspects: methodology and tools. Regarding tools, several kinds of tools are necessary to meet the requirements of the DRIVER Test-bed. Indeed, during the experiments, the DRIVER Test-bed will have to support data collection and simulations that allow the mix of live and simulated actions. Therefore, simulation tools, orchestration tools (including evaluation tools) are required.

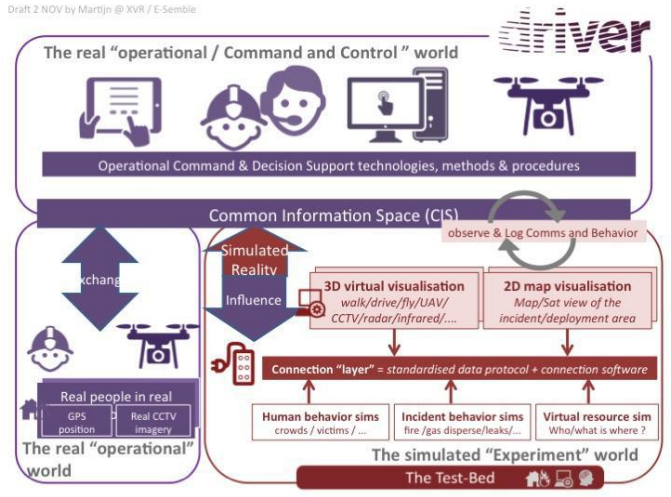

Figure 1: Technical infrastructure of the Test-bed

This deliverable, and more broadly Task 22.2, is focused on what simulation tools can be integrated in a DRIVER Test Bed to support the performance of experiments following DRIVER experimentation process. As part of this work, this task aims at investigating tools (especially simulation tools) provided by DRIVER partners and from other sources. Each investigated simulation tool is described according to the level of detail required to realize the DRIVER experiments.

To achieve this objective, the task T22.2 is linked to other tasks of the DRIVER project. As illustrated by Figure 2: Relationship between T22.2 and other tasks of DRIVER project, T22.2 provides information to T24.2 (Test-bed Integration) and T53.2 (Develop methods and tools for identifying, collecting and analysing lessons) based on the results of T21.2 (State of the Art and Objectives for the DRIVER Test-bed) and T21.3 (CM Experimentation Community of Interest). Therefore, this task will use deliverables of T21.2, T21.3, T82.1 (Crisis Management Processes & Organisations) and T82.2 (Crisis Management Processes & Organisation). T22.2 has also strong links with SP4 regarding the

exchange of data about the simulation models (static and dynamic data, formats, scenario data…). The current deliverable D22.21 of T22.2 will be used by T24.2, T53.2 and SP4.

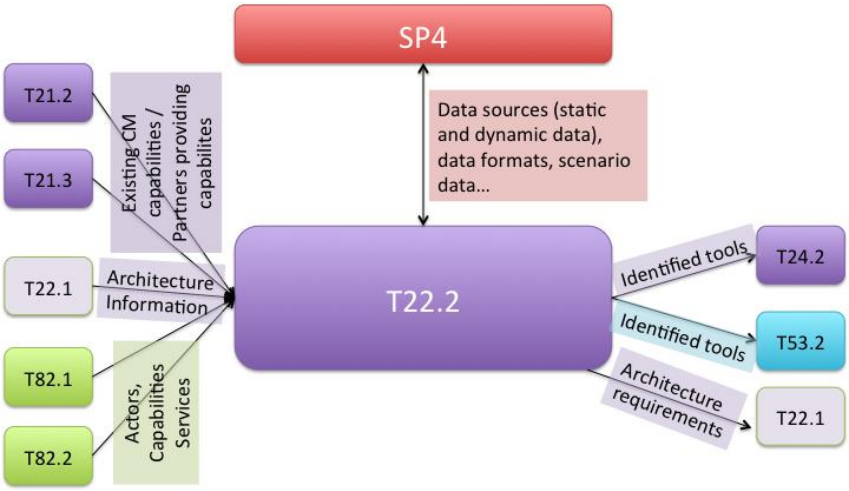

Figure 2: Relationship between T22.2 and other tasks of DRIVER project

1.2 Glossary of terms

Before going further in the description of the results, specific terms are defined in order to provide a common ground for understanding the DRIVER's simulation approach.

- Taxonomy:

Taxonomy is a systematic classification of some elements in an ordered hierarchical system. Relationships between taxonomy categories indicate natural relationships between these elements. In the context of the DRIVER project, an element is a simulation tool. A simulation or orchestration tool may be linked to one or more categories.

- Simulation model:

A simulation model is a physical, mathematical, or logical representation of a system, entity, phenomenon, or process [2] [4].

A simulation model can be composed of several simpler simulation models (e.g. a crisis could be modelled through several models concerning, for example, the treatment system (e.g. first responders capabilities), the crisis situation and environment, etc…)

- Simulation tool:

A Simulation tool is "a tool that performs a simulation" (US Department of Defense, 2011). In other words, it is a realization of a model, or a platform on which one or more models are realized.

- Simulation

A simulation is a "method for implementing a model over time" (US Department of Defense, 2011).

- Environment

The environment (or environment system) is defined as the part of the world affected by the crisis. It contains all the elements that can be concerned by the crisis situation, and/or that can influence the crisis situation (physical descriptions of goods, roads and buildings, behavioural description of people, etc.).

The environment could be seen as the real world environment of the System of Interest (i.e. the Crisis Management System of Systems).

- CM actors and/or CM systems

(ISO, 2011) and (ACRIMAS, 2012) define crisis management as the "process of planning and implementing measures aimed at preventing, reducing, responding and recovering from a crisis."

In the DRIVER context, Crisis Management actors (e.g. first responders) and/or CM systems (e.g. a detection system) embed(s) all actors, capabilities and resources deployed to solve (or at least to reduce) the crisis. Consequently, such treatment system contains involved actors (first responders) as well as crisis management systems (structure of sea walls, dikes etc.).

- Scenario

(US Department of Defense, 2011) defines a scenario as "An initial set of conditions and timeline of significant events imposed on trainees or systems to achieve exercise objectives."

Thus a scenario could be seen as the dynamic description of the crisis. It contains the timeline of events that describes the crisis progress.

- Experiment

As defined in D23.11, e*xperimentation in DRIVER involves the testing of novel "solutions" (a mix of existing and new technological, conceptual or organizational solutions) under controlled conditions with the following goals:*

a) assessing and improving resilience at different levels;

b) assessing potential operational benefits of technological tools and

c) developing methods and tools to support learning activities of crisis management professionals.

- Operational tool

An operational tool is a real world system such as a crisis management visualization tool (example: maps). It could be a situation assessment tool (WP43), a tasking and resource management tool (WP44), etc.

- Experiment support tools

An experiment support tool is a software object used to support the experiment implementation because of the possibilities it offers like orchestration, data collection, etc. In contrast to operational tools, experiment support tools are only introduced to enable and enhance the experiment and would not be present in a real operational situation.

1.3 General context

The experiments supported by the DRIVER Test Bed aim at covering a wide variety of crisis management situations. A crisis management simulation has to take into account the interactions between three subsystems within a crisis management: (i) the environment impacted by the crisis, (ii) the CM actors (or response systems) and (iii) the crisis itself. Therefore, various simulation models need to be connected to achieve the desired effects.

Crisis management, and consequently the simulation tools used, requires information about (i) the specific environment of the crisis, (ii) the specific crisis management system available to solve the considered crisis and (iii) the specific scenario of the crisis. Consequently, the DRIVER Test Bed has to be able to simulate a scenario, an environment and a crisis management system, according to the experiment requirements.

"one **scenario** to run over one **environment** and **crisis management actors and systems**"

Example: one specific flood scenario (scenario) over one specific European territory (environment) with a specific dike network and one evacuation plan (crisis management system and procedure).

As shown in Figure 3: Crisis management sub systems (from DRIVER deliverable D22.11)[8], a simulation model of crisis management can be decomposed into several models of subsystems that compose the simulated situation.

A simulation model of the whole crisis event can thus be considered as the union of several simpler simulation, impact and response models.

These models will be the input to the simulation tools. Indeed, a simulation tools is a piece of software that could simulate several situation. Therefore, a simulation model is used in order to provide information about a specific experiment to the simulation tool.

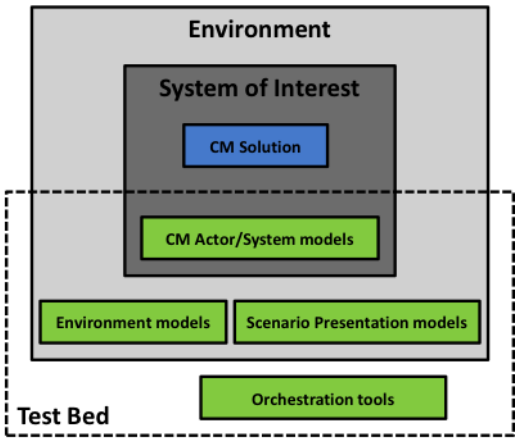

Figure 3: Crisis management sub systems (from DRIVER deliverable D22.11)

During an experiment, actions could be performed by real tools/actors or by simulation tools when real tools/actors are not available or are not considered under the subject of interest for the experiment. SP2 and Experiment leader are working simultaneously on the experiments:

- Experiment leader is interested in defining and preparing the experiments in close cooperation with platforms providers: crisis scenario, involved actors, tool providers, crisis management tools (*i.e.* operational tools), etc.
- SP2 mainly focuses on supporting experiments through simulation tools and experiment support tools such as orchestration, data collection and analysis.

Hence, the following assumption could be made: when someone wants to design an experiment, he has to select a set of relevant SP4 tools that would be really used in the selected scenario and at the same time SP2 tools simulating the reality that is not included in the scenario by any reasons (availability, out of the scope, lack of interest…). Those tools have to work together, in a complementary manner, so that the objectives of the experiments could be reached.

As a consequence, the simulation tools, and also other kinds of tools (operational tools, Test-bed tools), have to be described through several aspects: what are the inputs (*e.g.* required information) and the generated outputs (*e.g.* results), the price of the tool, etc. In addition, it is also necessary, for each experiment, to keep a list of the tools (simulation and operational) used in order to define the existing links between tools.

Finally, the way to collect and maintain the gathered information related to the simulation tools should guarantee a long-term sustainability. Thus, it must be possible to add new simulation tools and experiments even when the DRIVER project will be over. This requirement is particularly important because as there is a lot of simulation solutions, the scope will be focused on proposing a solution for adding and describing simulation tools with a long-term sustainability better than defining an exhaustive list of existing simulation tools.

1.4 Approach

To achieve the goals described in the previous Section 1.3, Task 22.2 has collected and reviewed information related to simulation, experiments, operational tools and the link that could be made between them. For this purpose a questionnaire and a website were created and can be found at the following URL address: http://driver-cat.mines-albi.fr/

The following section presents the approach used within this task in order to achieve its objectives.

1.4.1 Overview of the approach

DRIVER's approach for classifying and describing simulation tools is shown in Figure 4: Overview of the approach.

The process starts with a survey of existing simulation tools by DRIVER partners through the establishment and the dissemination of a questionnaire (see chapter 2). This questionnaire allows gathering data about simulation tools, and locates them within the three sub-systems structure (*i.e*. Environment, CM actors and/or CM systems, Scenario) so that, during the further experiments, these tools could be used to implement each of them if required. Then, based on DRIVER experimentation

needs, relevant simulation tools will be explored deeper and their description will be improved (with the help of a more precise questionnaire).

Reviewed simulation tools will be organized according to a taxonomy, enriched with the information from the questionnaire answers, to help the users to select relevant tools (see chapter 4).

Investigation, selection, and description are iterative steps.

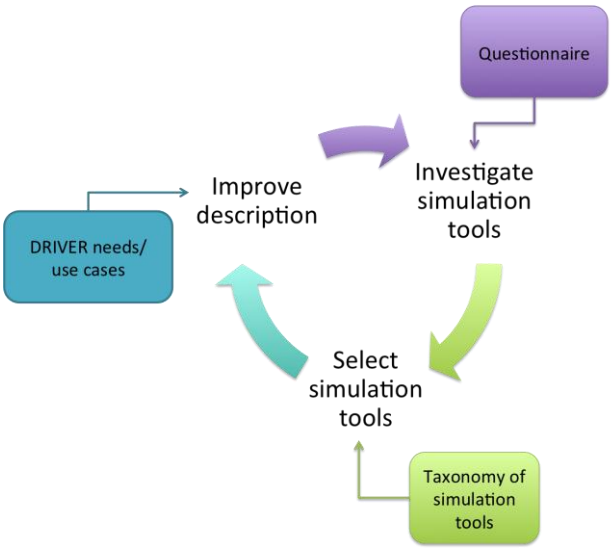

Figure 4: Overview of the approach

1.4.2 Lifecycle of the deliverable

This deliverable is developed in four iterations identified by the deliverable number D22.2n (where n goes from 1 to 4). Each version of this deliverable has different objectives.

- D22.21 is focused on the way to gather information about simulation tools with no deep description of the reviewed simulation tools.
- D22.22 will list information on a larger number of simulation tools. Moreover, in order to support experiments, this deliverable will propose a set of evaluation grids that will facilitate to link experiments needs and simulation tools and/or models.
- D22.23 and D22.24 will present results of evaluation grids defined in D22.22 and will be more focused on a detailed description of simulation tools and/or models used for the experiments.

D22.22 and this deliverable come as the inputs to Task 22.1 (Architecture and Infrastructure), Task 24.2 (Test-bed Integration) and Task 53.2 (Develop methods and tools for identifying, collecting and analysing lessons). These deliverables will indeed include more and more information about tools (especially simulation tools) in order to meet the requirement of experiments. The aim of the Driver-Cat is to cover more and more information about tools owned by Driver partners and other simulation tools in order to provide a set of tools usable for an experiment. Therefore, the number of tools described in the Driver-Cat has to grow during and after the DRIVER project.

D22.23 and D22.24 are used as input to Task 22.1 (Architecture and Infrastructure), Task 24.2 (Test-bed Integration) and Task 53.2 (Develop methods and tools for identifying, collecting and analysing

lessons). Therefore, Driver-Cat will also include more detailed information about simulation tools for a specific experiments and models used in order to configure simulation tools.

However, the timeline of the deliverable was not in line with requirements of experiment leaders and with the long-term sustainability of the DRIVER Test-Bed. Therefore, it was decided to convert the next iterations of this deliverable into a website, the DRIVER-CAT, that will be continuously updated by tool owners or experiment designers, even after the end of the DRIVER project. In this way, the DRIVER-CAT will be one of the visible components of the future DRIVER Test-bed.

1.5 Document overview

As introduced in previous sections, Task 22.2 aims at gathering information about simulation tools and / or models and spreading them to the experiment leader even after the end of the task. Therefore, this deliverable is divided as follows:

- Chapter 2 explains the way to gather information about simulation tools, especially the investigation of simulation tools from an experiment point of view, and the content of the questionnaire;
- Chapter 3 presents the DRIVER-CAT, which is a website used to spread information about tools;
- Chapter 4 presents the current results of the investigation and criteria that could be used to select tools by an experiment leader.

2 Questionnaire to review simulation tools

A simulation tool is developed in order to simulate a part of a crisis situation, which can be linked to one or several dimensions of the simulated situation. However, the main point is to know which kind(s) of elements these simulation tools can simulate for each dimension of the simulated crisis situation.

A questionnaire is used in order to gather information about simulation tools. This questionnaire will be improved all along the task lifecycle: further versions of the questionnaire will contain more detailed questions (and possibly additional categories). The current version of the questionnaire is divided into three main parts:

1. Experiments' requirements regarding simulation models and tools,
2. Information needed by experiments about simulation models and tools features,
3. General and Technical information about simulation models and tools,

This questionnaire will be used by DRIVER partners to review the actual functionalities of the simulation tools / characteristics of simulation models, in the same way that operational tools were reviewed by SP4 partners during their first round of experiments. Simulation tools and simulation models will be demonstrated during a combined WP22/WP24 workshop, focusing on their functionalities. The concerned DRIVER partners are WP22 and WP24 partners, and experiment leaders. The following sections will describe each part of this evaluation questionnaire.

The current version of the evaluation questionnaire is available in Annex and all the results are available on the driver-cat website: http://driver-cat.mines-albi.fr/

2.1 Experiments' requirements regarding simulation models and tools

The first part of the questionnaire is focused on the experiments themselves (see Annex Section 8.1). The aim is to gather the needs of the experiments regarding WP22 simulation tools and models. Thus, it will support the decision making process to choose relevant simulation models and tools to perform an experiment. The questionnaire will help to identify:

- The main aims of an experiment.
- The involved SP4 CM tools and their purpose in the experiment.
- The experiment needs from a WP22 point of view, i.e. the features and/or data not provided by SP4 tools and necessary to properly run the experiment.

Feature and data are detailed with a description (example: "geographical data about the plume dispersion are required as an input of the experiment") and additional information about unit, dimension or any relevant functional information (example: "GPS WGS84 coordinates").

Experiment leaders, helped by WP22 partners, will fulfil it.

2.2 Information needed by experiments about simulation models and tools features

To support the experiments preparation through the choice of simulation tools, this part of the questionnaire is intended to review the features of each simulation tool. Features are evaluated considering their use into a simulation context. This part of the questionnaire is based on the evaluation grid of SP4 CM tools (which was done during the SP4 Inventory of Tools in Aix-en-Provence). As the simulation models and tools will support the experiments by filling the functionalities considered as not relevant for the experiments among concerned SP4 CM tools, the evaluated features aim to follow the ones provided by SP4 CM tools (from preparation phase to response phase) but from a simulation point of view.

The detailed table, available in Annex, aims to evaluate features and cover several topics:

- Damage and needs assessment,
- Sensor processing,
- Crisis dynamics and early warning,
- Interaction with citizens,
- Shared situation awareness,
- Capacity building and capacity mapping,
- Tasking and capacity monitoring,
- Volunteer management support,
- Scenario.

Task T22.2 partners will evaluate simulation tools and models during a demo session where simulation tools/models providers will demonstrate the features of their tool.

It is interesting to note that some features are linked to the data of interest: fake sensors, distribution of fake warnings, crisis characterization (risks for instance).

2.3 General and Technical information about simulation models and tools

In this section, general information about the simulation tool is collected: its name, a short description, its owner, a reference (basically a URL) and its usage history (see Annex).

2.3.1 Name

This part concerns the name of the tool. This may typically be an acronym, complemented with its meaning.

2.3.2 Short description

A short and objective description of the tool is included here. In this part, marketing language should be omitted. The person, who describes the tool, should consider the following aspects for inclusion: intended application or use, main functionalities.

2.3.3 Owner

The name of organization(s) owning the simulation tool is referenced here.

2.3.4 Reference

“Reference” part aims to present a URL referring to a more complete description of the simulation tool.

2.3.5 Usage history

All previous and current uses of the tool are listed here:

- Has the tool been used in CM test-beds and or CM exercises?
- Has it been used in previous/other EU projects?
- Is a report available for DRIVER?

If applicable, the reviewer is asked to give references.

2.4 Users

In this part of the questionnaire, the focus is set on the users of the simulation tool. This provides an overview of the real use of the simulation tool (Who? How many?).

2.4.1 [A1] Number of users

An estimation of the current number of users of the tool is given here.

2.4.2 [A2] Intended users

“Intended users” covers the type(s) of users/groups to whom the tool is meant to be of support.

2.4.3 [A3] Community

If a user community exists (or has existed), it is referenced here with its current state (alive or not).

2.5 Characteristics

The “Characteristics” part focuses on the set of capabilities offered by the simulation tool: capabilities, CM level, level of aggregation, scenarios, services and feedback.

2.5.1 [B1] Capabilities

The simulation tool was designed to meet one or several needs in the domain of crisis management (or in a more generic domain). One or more capabilities of the tool can be applicable in CM, like:

- CM Training.
- CM Exercise support.
- Testing new CM equipment.
- Concept development.
- Supporting situational awareness.
- Predicting impacts of disaster (earthquake, tsunami, forest fire, etc.).
- Waste management.
- Resource management.
- Other (please specify).

The reviewer has to detail the selected capabilities, in a free format for the first version of the questionnaire. A feedback on the gathered information will help to define a framed format to collect more accurate information about this point in further questionnaires.

Moreover, it is taken into account that a single tool or a combination of tools can provide combined capabilities (if applicable, the reviewer has to explain it).

2.5.2 [B2] CM level

The tool can cover various CM level(s). The reviewer can choose among the following values:

- Strategic.
- Tactical.
- Operational.
- Other (please specify)

Strategic, tactical and operational CM levels should be understood as follows (with considerable simplification): the strategic level is occupied with defining objectives and finding resources, the tactical with defining actions to achieve the objectives and allocating resources and the operational with executing actions and using resources.

2.5.3 [B3] Level of aggregation

This question focuses on the level(s) of aggregation of the simulation tool (input and/or output). Available answers are:

- Individuals.
- Team.
- Team of teams.
- Other (please specify).

2.5.4 [B4] Scenarios

The simulation tool was intended for one or several kinds of disaster situations. If the scenario focuses on a specific area or event, the reviewer should specify it (e.g. flood mitigation scenario in the South area of France / evacuation of people dedicated to Olympic Games events).

The reviewer selects applicable scenarios that the tool can support among this (non-exhaustive) list of disaster situations:

- Fighting fires (forests, tunnels, harbours, oil terminals, etc.).
- Flood mitigation (tsunamis, rivers, etc.).
- Severe weather conditions (storms, ice storms, rain, drought, etc.).
- Evacuation of large population (refugee waves due to war or industrial disasters, etc.).
- CBRN (Chemical, Biological, Radiological and Nuclear) disaster (chemical cloud, contaminants in river, nuclear cloud, etc.).
- Natural disaster (earthquakes, tsunamis, floods, volcano eruptions, landslides, etc.).
- Industrial disaster (nuclear plant accidents, petrochemical plant accidents, etc.).
- Pandemics, epidemics, outbreaks of contagious diseases.
- Terrorist attacks (airports, public transport and facilities, public areas, large events, schools, general stores, etc.).
- Other (please specify).

If the tool can support several scenarios or a combination of scenarios, this should be noticed and explained.

For each scenario, the major entities *(e.g. policemen, civilians)* and their interactions *(e.g. evacuate civilians)* with the environment *(e.g. contaminated area)* and other entities that are modelled by the tool are listed.

2.5.5 [B5] Services

In this part, the focus is set on the kind of simulation allowed by the reviewed simulation tool, and also its services and functionalities. The reviewer answers the following questions:

- Does the simulation tool allow simulating…?
  - A scenario (cf. [B4]).
  - A model of CM actors (e.g. first responders) or CM systems (e.g. a detection system) *(please explain).*
  - A physical environment (e.g. a plant, a city) *(please explain).*
- Which kinds of services does the simulation tool offer? (please explain).
  - Visualization of the information (e.g. maps, layers, diagrams).
  - Generation of datasets.
  - Data analysis.

- Other (please specify).

2.5.6 [B6] Feedback

Feedback questions focus on the support of such a capability, the collected data (if any) and the reproducibility of the simulation:

- Does the tool support a feedback capability (like a recording capability to replay the simulation)?
- If any data is collected for feedback, what is it (nature, format)?
- Does the tool allow reproducing the simulation (i.e. for a given input, the output will remain the same)?

2.6 I/O data

This part focuses on the input and output data of the reviewed simulation tool. Data is presented considering the business level, as technical aspects (e.g. standard, format) of inputs and outputs will be detailed in the remainder of the questionnaire.

2.6.1 [C1] Input data

What kind(s) of data does the simulation tool require? What data are needed for the tool configuration?

E.g.: maps, inventory of partners' capabilities, GPS coordinates, number of people, etc.

2.6.2 [C2] Output data

What kind(s) of data does the simulation tool produce and exchange with the user/other tools?

E.g.: weather conditions, task scheduling, situation reports, maps, etc.

2.7 Technical aspects

Technical aspects cover the way the tool can operate with DRIVER Test-bed and/or with other tools.

2.7.1 [D1] Connectivity

Is the tool able to connect with other tools from its tool suite (if applicable) or from third parties?

If so, the reviewer is asked to fill in D2 and D3 sections to detail the interoperability capabilities of the tool. If not, the reason should be textually explained.

2.7.2 [D2] Interfaces

What are the available technical interfaces and protocols and the supported data formats to allow data exchange?

Data formats:

- EDXL (Emergency Data Exchange Language)
- KML (Keyhole Markup Language).
- SensorML (Sensor Model Language).
- GML (Geography Markup Language).
- XML (EXtensible Markup Language).
- JSON (JavaScript Object Notation).
- CSV (Comma-Separated Values).
- Proprietary format (please specify).
- Other (please specify).

Technical interfaces and protocols:

- HLA RTI (High-Level Architecture Run-Time Infrastructure).
- SOAP (Simple Object Access Protocol).
- REST (REpresentational State Transfer).
- XMPP (Extensible Messaging and Presence Protocol).
- JMS (Java Message Service).
- Other (please specify).

For each supported interface, it is specified the information that goes across it and in which direction. Example of kinds of data that may go across the interface: entity state data, interactions between entities, execution control data (pause/resume, start/stop), time management data (e.g. for non-real time simulation), synchronization data and triggers.

2.7.3 [D3] Platform

This part focuses on the operating system used to run the tool: Windows, Mac, Linux (minimal version of OS has to be specified).

2.7.4 [D4] Security requirements

Is the tool subject to security constraints, such as?

- Encryption of data communication.
- Access management.
- Other (please specify).

2.7.5 [D5] Hardware requirements

This part is filled only if applicable. It concerns the minimal hardware requirements to use the tool:

- Processor.
- RAM.

- Available hard disk space.
- Graphic device, resolution.

2.7.6 [D6] Performances

These concern the time/space performances and the scalability of the simulation tool:

- How many entities and events can the simulation tool handle simultaneously?
- If an environment is simulated (city, plant, forest, etc.), what is the maximum size of the virtual terrain?
- How fast (real time? n*real time?) can the tool simulate for a given number of entities?

2.8 DRIVER integration

2.8.1 [E1] Licensing

In judging the integration of the tool within the DRIVER Test-bed from a licensing point of view, the reviewer has to investigate aspects such as:

- What is the licensing structure for tool usage *within* DRIVER?
- What is the licensing structure for tool usage *after* DRIVER?
- Which additional software is required to use the tool? What are the licensing conditions for this software?

If the tool is Open Source, the kind of license (LGPL, BSD 2-Clause, etc.) should be specified.

2.8.2 [E2] Expectations

If the DRIVER Test-bed would exist today, what kind of service or support would be required for the evaluated simulation tool in order to work in the DRIVER Test-bed?

2.8.3 [E3] Contributions

If the DRIVER Test-bed would exist today, what kind of service or support would the evaluated simulation tool give to other Test-bed tools/participants?

2.8.4 [E4] TRL – Technology Readiness Level

TRL [6] focuses on the maturity level of the solution or development. The level is selected from the following list:

- TRL 1 – basic principles observed.
- TRL 2 – technology concept formulated.
- TRL 3 – experimental proof of concept.
- TRL 4 – technology validated in lab.

- TRL 5 – technology validated in relevant environment (industrially relevant environment in the case of key enabling technologies).
- TRL 6 – technology demonstrated in relevant environment (industrially relevant environment in the case of key enabling technologies).
- TRL 7 – system prototype demonstration in operational environment.
- TRL 8 – system complete and qualified.
- TRL 9 – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space).

The reviewer can textually explain and underpin the assessment score.

2.8.5 [E5] Foreseen developments

Considering the duration of the DRIVER project and its aim to deliver a Test-bed, the foreseen evolutions of integrated simulation tools (suites) have to be taken into account.

What are foreseen developments for the evaluated simulation tool (suite) in the near future (over 1-3 years)?

3 DRIVER-CAT: gather and spread information

The Task 22.2 aims at gathering information about simulation tools and / or models and spreading them to the experiment leader even after the end of the task. A website was created: the DRIVER-CAT. This website aims (i) at helping the experiment leaders to find adapted simulation tools, and (ii) at allowing external providers to describe their simulation tools.

This part is divided into two sections: first an overview of the DRIVER-CAT is given and, then, some interesting functionalities are highlighted and can help experiment leaders to select tools.

3.1 Overview of the DRIVER-CAT

As illustrated in Figure 5: overview of the DRIVER-CAT, DRIVER-CAT is a website that provides information on experiments, operational tools and Test Bed tools (especially simulation tools). Thus, it is divided into five main parts:

1. **DRIVER Experiments**: Each experiment has a page. In this page, one can find the general purpose of this experiment, the tools used (simulation and operational) and the result of the evaluation of this experiment. Any identified user can add a new experiment.
2. **Operational tools**: Each operational tool is described. This description is based on the results of SP4 Tasks. Any identified user can add a new operational tool.
3. **DRIVER Test-bed tools**: This part describes the tools used by the DRIVER Test-bed, these tools could be simulation tools or orchestration tools. Orchestration tools are defined in [8]. Regarding the simulation tools, one can find the result of the questionnaire (presented in Section 2), for each of them.
4. **Glossary**: This part is a glossary that allows a harmonization of the terms used in the experiments, the operational tools and the simulation tools. Each term appears in green on the website (e.g. DRIVER and Crisis Management on the Figure 5: overview of the DRIVER-CAT).
5. **DRIVER Team**: This part lists the people that have an account on the DRIVER-CAT. For the moment, only DRIVER Partners have an account on the DRIVER-CAT but as soon as the DRIVER-CAT will be in a more stable version, it will be open to external users.

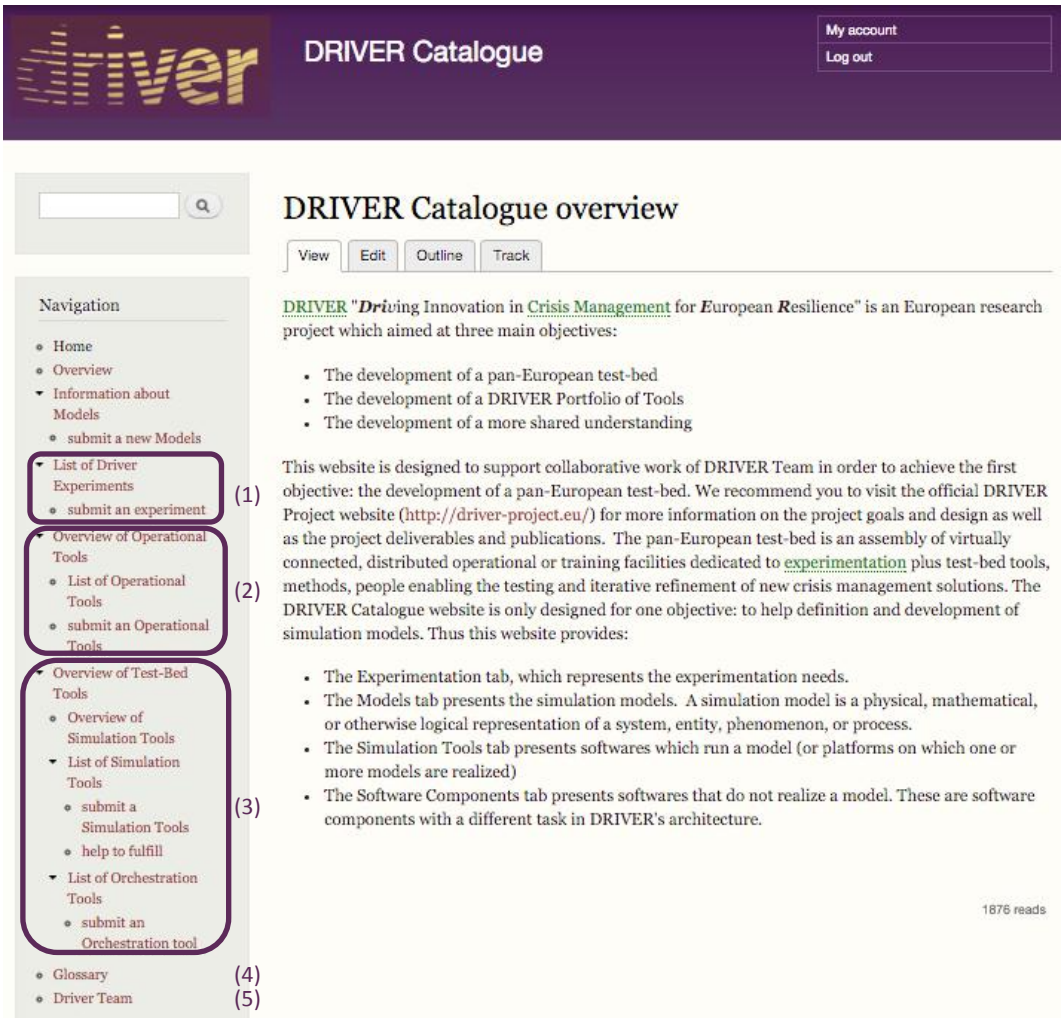

Figure 5: overview of the DRIVER-CAT

3.2 Functionality of the DRIVER-CAT

The DRIVER-CAT is a website and, as such, allows fast and easy access to information to the users. In order to achieve that, intuitive interfaces for the navigation and the description of the tools were developed. This section is focused on three functionalities of the DRIVER-CAT required to allows fast and easy access to information: (i) allowing rich media visualization, (ii) enabling image map and (iii) filtering data.

3.2.1 Describe Tools with rich media

Rich media allows the visualization of presentations (PowerPoint, PDF) as well as video or flash movies and comes as a good way to exchange information within the project. A preview tool is available for the experiments designers and proves to be really useful for visualization tools like 2D or 3D maps.

3.2.2 Browse Catalogue: Image maps

Image maps is a functionality that allows users to navigate through several levels within a picture. An area of a picture becomes clickable and can lead to another granularity level.

Figure 6: Example of image map functionality, shows an example: the user starts from the overview of the DRIVER-CAT, then he clicks on the Test-bed region. Then, he arrives on the Overview of the Test-bed picture and he clicks on the Data generation by simulation region. Finally, he gets the overview of simulation tools on the topic and he can click on the Sumo tool (because he would like a road traffic simulation tool) and obtains a description page of the SUMO tool with, for example, associated rich media.

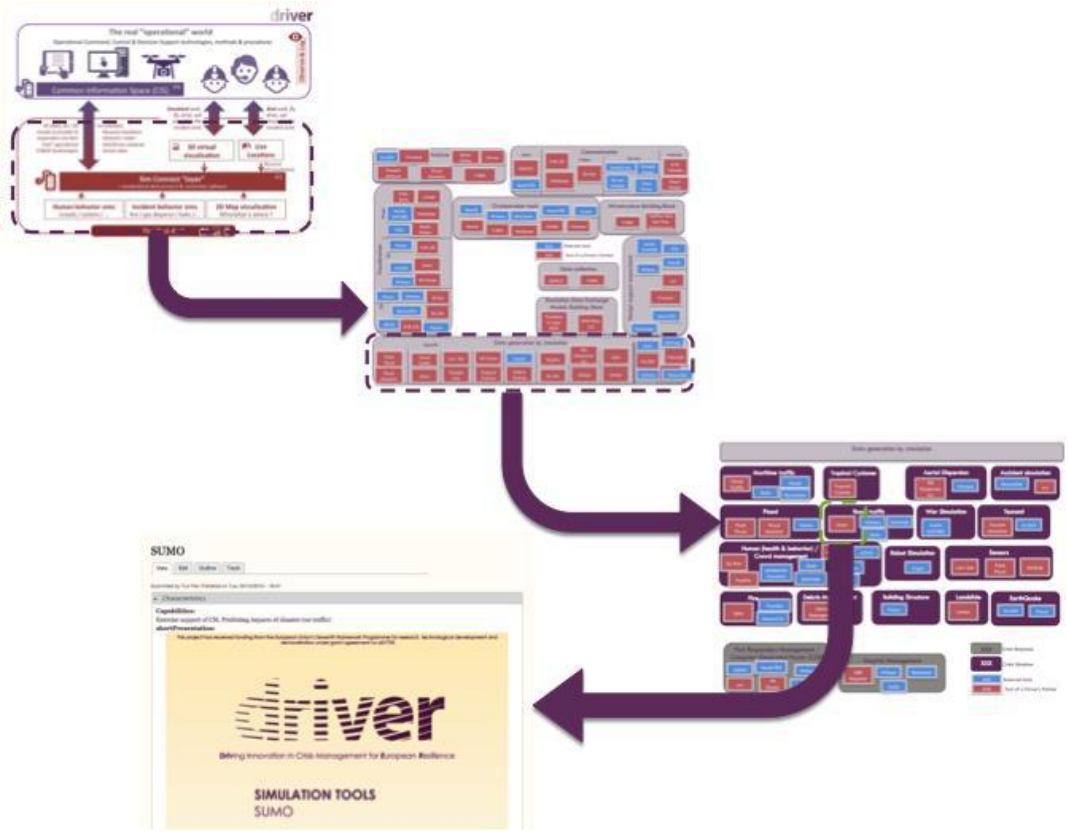

Figure 6: Example of image map functionality

3.2.3 Filtering tools

This functionality is widely used because it allows users to find tools based on their filtering requirements. This functionality is based on criteria developed on next Section.

4 Simulation tools investigation

This section describes the selection process of simulation tools in order to cover the requirements of the defined scenario or experiment.

The selection process is based on the experiment leader's needs. Experiment leaders will use the DRIVER Test-bed to evaluate CM tools (SP4) or to support CM training (SP5) and therefore to run experiments (SP6). Whatever the intended use is (evaluation, training, experimentation), users need to simulate a crisis situation according to their specific requirements to achieve their evaluation / training / experimentation objectives.

As a reminder, CM is too complex to be served by a single simulation tool. Thus, a set of simulation tools should be selected by the users and combined together to obtain a whole simulation on a DRIVER Test-bed.

Thus, the selection of relevant simulation tools for a given simulated crisis situation should be based (as a first step) on four criteria: Cost, Mission domain, Type, and Service of the simulation tool.

- **Cost** is the price of the simulation tools.
- **Mission domain** is the kind of disaster/emergency situation (as investigated by [B4] in the questionnaire).
- **Type** is the kind of tool (as investigated by [B5] in the questionnaire).
- **Service** represents the service(s) offered by the tool (as also investigated by [B5] in the questionnaire).

This first step allows focusing on the most relevant tools (according to user's wishes) from a non-technical point of view. The user will filter the available simulation tools by setting values to Cost, Domain, Type and Service criteria.

Then, as a second step, the selection should be refined on other criteria, such as legal aspects (licensing), technical aspects (performance, format, security, etc.). This refined selection will be the object of further versions of the deliverable and DRIVER-CAT since currently only the technical aspects are studied in detail for the simulation tools.

The following part of this section presents two approaches for selecting simulation tools. The first one is based on the requirements of the experiments and, consequently, an overview and image map functionality are presented. The second one is based on criteria filtering applied to simulation tools.

4.1 Overview of the simulation tools

This Section presents the results of the simulation tools investigation, with respect to their functionalities. The following pictures, Figure 7: Overview of tools based on service offered, and Figure 8: Overview of simulation tools based on mission domain, help experiment leader to select simulation tools. These pictures also constitute the image map of the DRIVER-CAT.

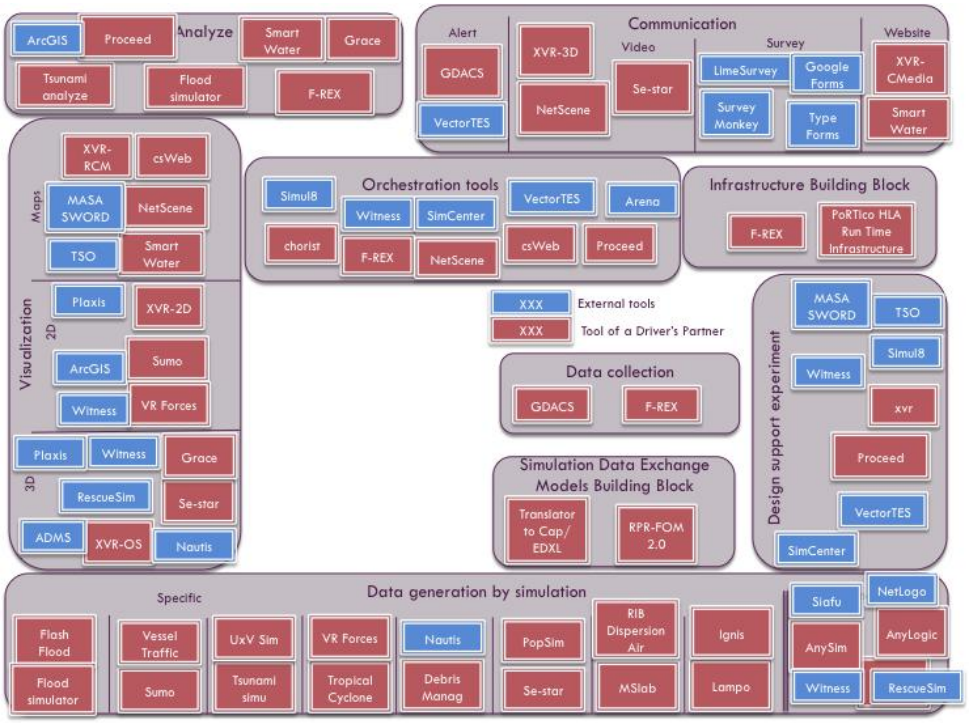

Figure 7: Overview of tools based on service offered

In these two pictures, tools (simulation tools and orchestration tools) are represented by a rectangle, red for the tools owned by DRIVER partners and blue for the external tools. They are placed in different areas of the picture, based on their functionalities. Therefore, several rectangles could refer to the same simulation tools.

In Figure 7: Overview of tools based on service offered, some represented tools are not simulation tools but are infrastructure tools of the DRIVER Test-bed. If you need more information about them please visit the DRIVER-CAT (https://driver-cat.mines-albi.fr/).

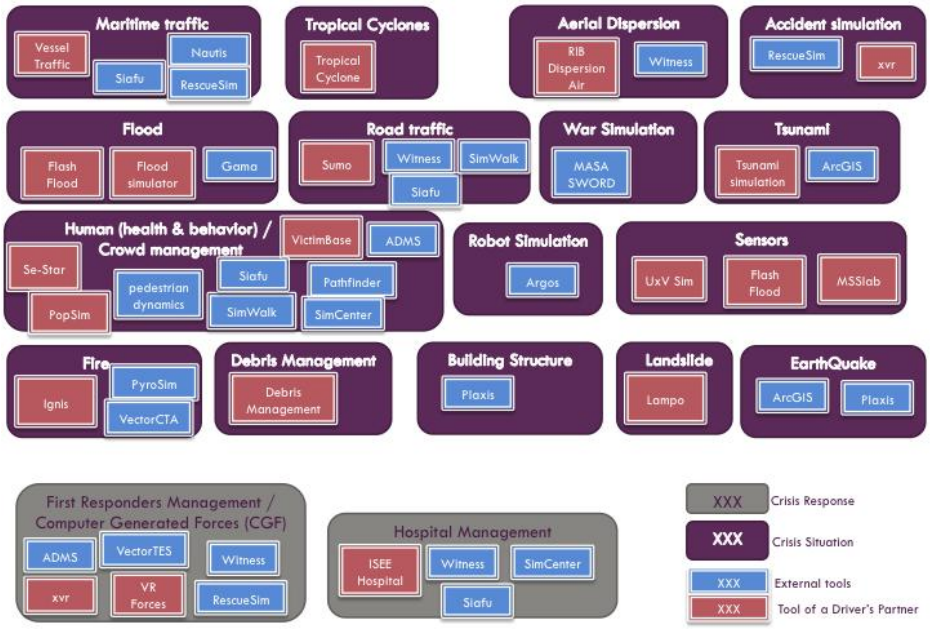

Figure 8: Overview of simulation tools based on mission domain

4.2 Simulation tool selection criteria

This section presents the results of the simulation tools investigation with respect to the criteria filtering. Therefore, this section is divided in three parts: costs criterion, mission domain and service offered by simulation tools.

4.2.1 Cost criterion

Table 1: Result of the cost criterion, presents the result of simulation tools investigation under the respect to price. This table describes for each simulation tool the level of cost, the license, the owner and the TRL.

Simulation Tool	License	Owner	TRL
Smart Water	No licenses requirements	DG ECHO and Smart Water consortium team	1
GAMA	Open Source license	Alexis Drogoul	2
RedSpider Enterprise	Not alluded to on their website	IONIC Software	4
MSSLab	There are tools in MSSLab that has licensing cost, but MSSLab would not be delivered as a part of the Test-bed; tools modified and tuned to the Test-bed would be using the parts of MSSLab that are license free, depending on which exchange technology to use.	FOI	4
SUMO	Open Source license: GPLv3+	DLR	4
AnySim	To be defined	Thales Communications & Security	4
TSO Editor	Open Source license: GPL license version 2	Edisoft	5
ITS Modeler		TNO	5
SE-STAR	Internal Thales only. But, if needed by partners, limited time with dongle protection system.	Thales Services - ThereSIS	5
Siafu	Open Source license: GPL license	NEC Europe	6
ARGoS	Open Source license: MIT license	project funded by the European Research Council	6
NetLogo	NetLogo is free, open source software under the GPL (GNU General Public License), version 2, or (at your option) any later version.	Wilensky, U. Center for Connected Learning and Computer-Based Modeling, Northwestern University	6
Vessel Traffic Generator	Requires VR-Forces license.	TNO	6
VR Forces	Commercial: Mak	TNO	6

Simulation Tool	License	Owner	TRL
UxV Sim	TNO license	TNO	6
GRACE	TNO license	TNO	6
Ignis	Commercial	ECASC - Entente Valabre	6
NetScene	In-house only	FOI	6
POPSIM	If using HLA connector POPSIM is subject to the federate license of the Pitch RTI.	FOI	6
PROCeed	Per time period of access or per number of gameplays.	ITTI	6
SIMWALK	Commercial, price unknown for the moment	Simwalk Team	7
ISEE Hospital	Commercial	Counterpoint Communication, Netherlands Until mid 2015 contact E-Semble BV	7
PyroSim	Commercial, 1188 € per year or 3845 €HT	Thunderhead Engineering Consultants	8
Pathfinder	Commercial, 2517 €HT per year	Thunderhead Engineering Consultants	8
VictimBase	Free for profit license, license fee applicable for commercial use	EMDM Academy, Geneva	8
VECTOR TES	Commercial, price unknown for the moment	VectorCommand	9
VECTOR CTA	Commercial, price unknown for the moment	VectorCommand	9
SimCenter	Commercial, price unknown for the moment	Laerdal	9
Patient Simulators	Commercial, price unknown for the moment	Laerdal	9
ADMS	Commercial, price unknown for the moment	ETC	9
RescueSim	Commercial, price unknown for the moment	VSTEP	9
NAUTIS	Commercial, price unknown for the moment	VSTEP	9
MASA SWORD	Commercial, price unknown for the moment	MASA Group	9
Arena	Commercial, price unknown for the moment	Rockwell Automation	9
Simul8	Commercial, 26 995 € for company and 1995 € for university	SIMUL8 Corporation	9
Witness	Commercial, 20 000 € for industry or 3 000€ for academic and research purpose	Lanner	9
PLAXIS	Commercial	Plaxis bv	9
ArcGIS Geostatistical Analyst	A single use or concurrent use license	Esri	9
Tsunami	It requires agreement with JRC for launching the cases.	JRC	9

Simulation Tool	License	Owner	TRL
Simulation Environment			
Tropical Cyclones Simulation Environment	It requires agreement with JRC for launching the cases.	JRC	9
Flash Flood Simulator	Free to use for DRIVER project, it does not imply any third-party license.	JRC	9
Chorist Simulator	Free to use for DRIVER project, it does not imply any third-party license.	JRC	9
XVR On Scene	No information	MSB	9
RIB Dispersion Air	Free in the Driver context	MSB	9
XVR	The XVR Tool will be licensed for DRIVER participation for free, and reverts to the default licensing model afterwards.	E-Semble BV, Delft, The Netherlands	9
Anylogic	The simulation software AnyLogic, which is used to develop the simulation model is commercial and not open-source. The developed simulation model can either be tested directly in AnyLogic or as a Java applet.	The tool is sold by The AnyLogic Company.	9

Table 1: Result of the cost criterion

4.2.2 Mission Domain

Table 2: result of the link between simulation tools and missions presents the result of simulation tools investigation with respect to generated data for a use case.

Simulation Tool	Human/Crowd	Maritime traffic	Topical Cyclones	Aerial dispersion	Accident	Flood	Road Traffic	War	Tsunami	Robot	Sensors	Fire	Debris	Building structure	Landslide	Earthquake	CGF	Hospital activities
Smart Water						X												
GAMA						X												
RedSpider Enterprise																		
MSSLab											X							

Simulation Tool	Human/Crowd	Maritime traffic	Topical Cyclones	Aerial dispersion	Accident	Flood	Road Traffic	War	Tsunami	Robot	Sensors	Fire	Debris	Building structure	Landslide	Earthquake	CGF	Hospital activities
SUMO							X											
AnySim	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
TSO Editor																		
ITS Modeler																		
SE-STAR	X																	
Siafu	X	X					X											X
ARGoS										X								
NetLogo																		
Vessel Traffic Generator		X																
VR Forces																	X	
UxV Sim											X							
GRACE																		
Ignis												X						
NetScene																		
POPSIM	X																	
PROCeed																		
SIMWALK	X						X											
ISEE Hospital																		X
PyroSim												X						
Pathfinder	X																	
VictimBase	X																	X
VECTOR TES																	X	
VECTOR CTA												X						
SimCenter	X																	X

Simulation Tool	Human/Crowd	Maritime traffic	Topical Cyclones	Aerial dispersion	Accident	Flood	Road Traffic	War	Tsunami	Robot	Sensors	Fire	Debris	Building structure	Landslide	Earthquake	CGF	Hospital activities
Patient Simulators	X																	X
ADMS	X																X	
RescueSim		X			X												X	
NAUTIS		X																
MASA SWORD								X										
Arena																		
Simul8																		
Witness				X			X										X	X
PLAXIS														X		X		
ArcGIS Geostatistical Analyst									X							X		
Tsunami Simulation Environment									X									
Tropical Cyclones Simulation Environment			X															
Flash Flood Simulator						X					X							
Chorist Simulator																		
XVR On Scene																	x	
RIB Dispersion Air				X														
XVR					X												x	
Anylogic	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Table 2: result of the link between simulation tools and missions

4.2.3 Service offered by tools

Table 3: result of link between simulation tools and services, presents the result of simulation tools investigation with the point of view of functionalities proposed by simulation tools.

Tool	Analyse	Orchestration	Communication		Visualization			Design Support	Data Exchange	Data Collection
			Alert	Video	Maps	2D	3D			
Smart Water	X				X					
GAMA										
RedSpider Enterprise										
MSSLab										
SUMO						X				
AnySim										
TSO Editor					X			X		
ITS Modeler										
SE-STAR				X			X			
Siafu										
ARGoS										
NetLogo										
Vessel Traffic Generator										
VR Forces						X				
UxV Sim										
GRACE	X						X			
Ignis										
NetScene		X		X	X					
POPSIM										
PROCeed	X	X						X		
SIMWALK										
ISEE Hospital										
PyroSim										
Pathfinder										
VictimBase										

Tool	Analyse	Orchestration	Communication		Visualization			Design Support	Data Exchange	Data Collection
			Alert	Video	Maps	2D	3D			
VECTOR TES		X	X					X		
VECTOR CTA										
SimCenter		X						X		
Patient Simulators										
ADMS							X			
RescueSim							X			
NAUTIS							X			
MASA SWORD					X			X		
Arena		X						X		
Simul8		X						X		
Witness		X				X	X	X		
PLAXIS						X	X			
ArcGIS Geostatistical Analyst	X					X				
Tsunami Simulation Environment	X									
Tropical Cyclones Simulation Environment										
Flash Flood Simulator	X									
Chorist Simulator		X								
XVR On Scene				X	X	X	X	X		
RIB Dispersion Air										
XVR				X	X	X	X	X		
Anylogic										

Table 3: result of link between simulation tools and services

4.2.4 Legal criteria

The selection of a simulation tools can be constrained by the license associated with the tool.

Further versions of the questionnaire will integrate sufficient data to build a taxonomy focused on legal and licensing data.

4.2.5 Technical criteria

As explained in paragraph 1.4.2 about the questionnaire lifecycle, the first version of the questionnaire did not focused on technical details. Its aim is to gather enough general data to have an overview of the existing simulation tools.

Further versions of the questionnaire will provide sufficient data to build a taxonomy focused on technical data.

5 Conclusion

Within this deliverable, two main steps were performed. First, the establishment of a questionnaire has allowed designing the specific relevant criteria to evaluate the different tools. Then, this questionnaire has been spread over the partners so that more than 40 simulation tools could be assessed: some of them are owned by DRIVER partners and others are owned by external company to the project. All these evaluation have been made available to all the partners via a website, the DRIVER-CAT. This deliverable constitutes the first step of a three-times overall process: (i) investigation, (ii) selection, and (iii) description.

There are two main perspectives for the implemented DRIVER-CAT. First, using a website ensures a good long-term sustainability. As such, the catalogue will still evolve during the next steps of the DRIVER project (especially during, the experimentations), and after the end of the project, which will allow updating the information and keep a good overall view on the existing simulation tools. Second, the user-friendliness of the image maps browsing offers a way to easily find the tools needed, depending on the crisis context and situation. This aspect of the DRIVER-CAT is also going to be increased to offer new functionalities for faster and easier access to the relevant gathered information.

Hence, now that the DRIVER-CAT has been set up, the selection step can be now fulfilled. As a further step, the DRIVER Test-bed are going to be studied and the set of relevant simulation tools will be chosen using the DRIVER-CAT information and its selection support functionalities. Once simulation tools will be selected for an experiment, simulation models will be developed in order to meet the requirements of the experiments.

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Annex: Questionnaire

Experiments' requirements regarding simulation models and tools

Experiment title			**Experiment leader**	
Experiment short description and main aims			**Platform**	
Evaluator organization			**Evaluator name**	
Involved SP4 tools	**Name**		**Provider**	**Purpose in the experiment**
Experiment needs (not covered by SP4 tools)	**Feature**	**Data**	**Description**	**Unit, dimension, any relevant info**

Information needed by experiments about simulation models and tools features

Date	Evaluator organization	Evaluator name	Tool name			
				Feature available	Feature relevance for simulation regarding DRIVER experiments	Additional considerations (positive/ negative)
Simulation topic	Feature	Sub-feature		Yes / No / Partly	0=none 3=fully	free text
Damage and Needs Assessment	Gathering (fake) data from the field	Human readable info				
		Machine readable info				
	Situation analysis	Fake alerts				
		Simulated statistics and trend analysis				
	Assessment of (fake) risks	Risk catalogue				
		Effect catalogue				
Sensor processing	Assessment based on fake airborne sensors					
	Other fake sensor					
Crisis dynamics & early warning	Distribution of fake warnings (public and to operators of critical infrastructure and enterprises)	Preparation of warnings				
		Authorisation of warnings				
		Distribution of warnings				
Interaction with citizens	Usage of social media	Fake situational awareness info				

Date	Evaluator organization	Evaluator name	Tool name			
				Feature available	Feature relevance for simulation regarding DRIVER experiments	Additional considerations (positive/ negative)
		Pushing fake warnings via social media				
	Usage of crowd tasking	Info collection (simulated citizen as a sensor)				
		Supporting relief actions (simulated citizen as a volunteer)				
Shared situation awareness	Equipment/ Deployment	Simulating Control centers				
		Simulating Field devices				
Capacity Building and Capacity Mapping	Deployment of Resources	Simulated monitoring of current status of deployed resources				
	Selection of Resources Level	Simulate current resource level				
		Simulate decision on resource allocation				
	Crisis Characterization	Simulate other crisis characteristics				
		Risk				
		Effect				
Tasking and Capacity Monitoring	Resource Simulation	Positioning				
		Information (availability, status, resource level…)				

Date	Evaluator organization	Evaluator name	Tool name			
				Feature available	Feature relevance for simulation regarding DRIVER experiments	Additional considerations (positive/ negative)
	Assignment of (fake) Resources to (fake) Tasks	Information (availability, status, resource level…)				
	Tasks Management Simulation	Task Creation				
		Task Prioritization				
		Task Tracking, Reporting				
	Information Sharing	Manually (triggered by human)				
		Automatically				
Volunteer Management Supporting	Fake volunteer monitoring	volunteer skills				
		simulating status and availability				
	Fake volunteer tasking	Task assignment				
		simulating task tracking, reporting, monitoring				
Scenario	Definition of Scenarios	Design a scenario				
	Timeline	Play a timeline of events				
		Record a timeline of events				
	Cascade Effects	Characterization				

Date	Evaluator organization	Evaluator name	Tool name			
				Feature available	Feature relevance for simulation regarding DRIVER experiments	Additional considerations (positive/ negative)
		Design cascade effects				
Name				**General remarks to the tool**		
Description				**Overall impression**:		

General and Technical information about simulation models and tools

General information	
Name	
Short description	
Owner	
Reference	
Usage history	
Users	
[A1] Number of users	
[A2] Intended users	
[A3] Community	
Characteristics	
[B1] Capabilities	
[B2] CM level	
[B3] Level of aggregation	

[B4] Scenarios	
[B5] Services	
[B6] Feedback	
I/O information [Business view]	
[C1] Inputs	
[C2] Outputs	
Technical aspects	
[D1] Connectivity	
[D2] Interfaces	
[D3] Platform	

[D4] Security requirements		
[D5] Hardware requirements		
[D6] Performances		
DRIVER integration		
[E1] Licensing		
[E2] Expectations		
[E3] Contributions		
[E4] TRL	[1-9]	
[E5] Foreseen developments		