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EVALUATION METHODOLOGY USING BENCHMARKING

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Abstract:
This deliverable consists of a description of the ROBORDER Platform Evaluation Methodology Using Benchmarking. The methodology will be applied both to simulated testbeds for performance evaluation and to live demonstrations.
This deliverable includes also:

- The definition of a set of Key Performance Indicators (KPIs).
- Guides and templates for reviewing the KPIs and identifying benchmarks; ROBORDER Platform components data collection; Ground truth data collection for benchmarking; ROBORDER testing simulation capability survey.

The ROBORDER KPIs set has been updated addressing project reviewers' comments. The new set is obtained by simplifying the KPIs in the previous version of D6.1; Adding KPIs on Operators Performance; Adding KPIs on Economic Performance; Adding TRL KPIs.
KPIs are mapped against PUCs and are linked with the objectives set for ROBORDER.
A validation strategy for the KPIs is provided, formal validation events are identified.
The consortium has agreed on the KPIs reported.

2 Evaluation Methodology

The evaluation methodology will be used recursively to measure the performance evolution of the proposed ROBORDER Platform during the project life cycle. The results will show how ROBORDER meets the expectations introduced in the project proposal. The Evaluation Methodology process is divided into four phases as identified in Figure 1:

1. Define the parameters of the evaluation;
2. Design the methods used for the evaluation;
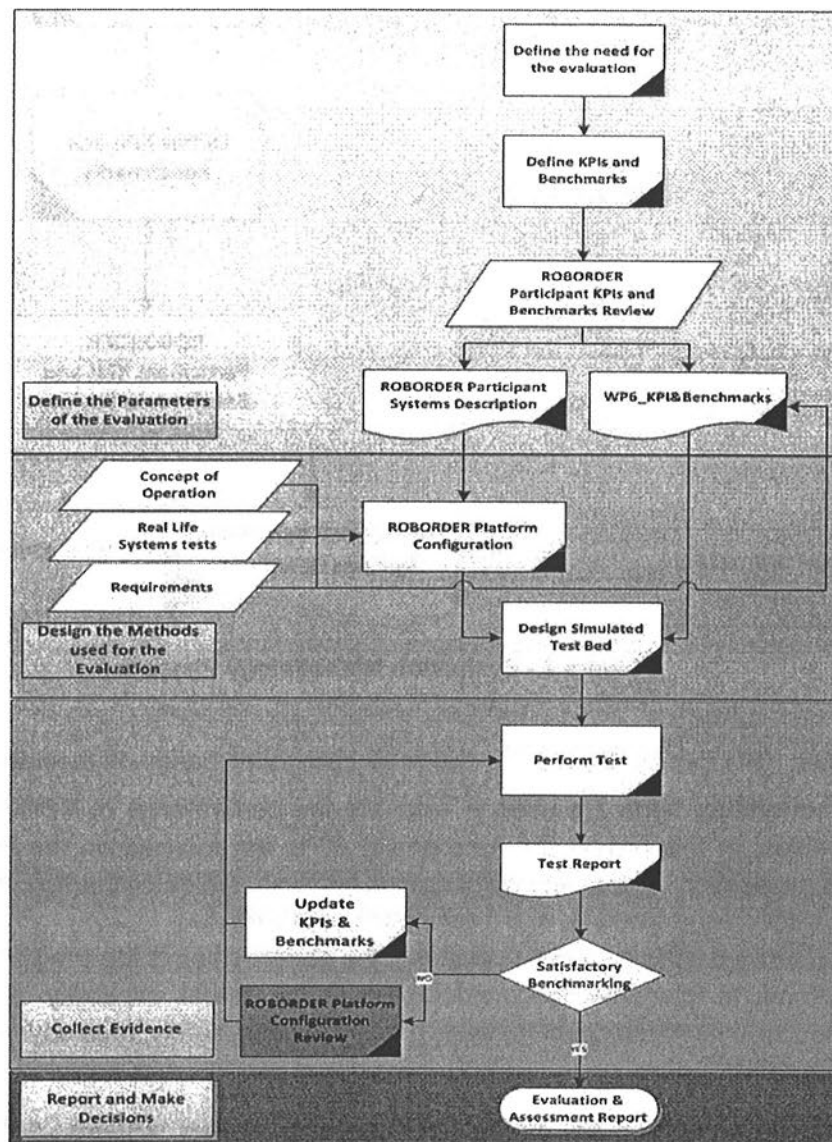3. Collect evidence;
4. Report and make decisions.

Figure 1 - Evaluation Methodology Flow Diagram

Phase 1: Define the Parameters of the Evaluation

An extended list of KPIs has been defined to support a quantitative evaluation of the ROBORDER Platform (Figure 2). Benchmarks will be identified to qualitatively assess the ROBORDER Platform capabilities, reliability, dependability, and performances. This approach follows state of the art benchmarking process (Baehr 2004; Fontana et al. 2017).
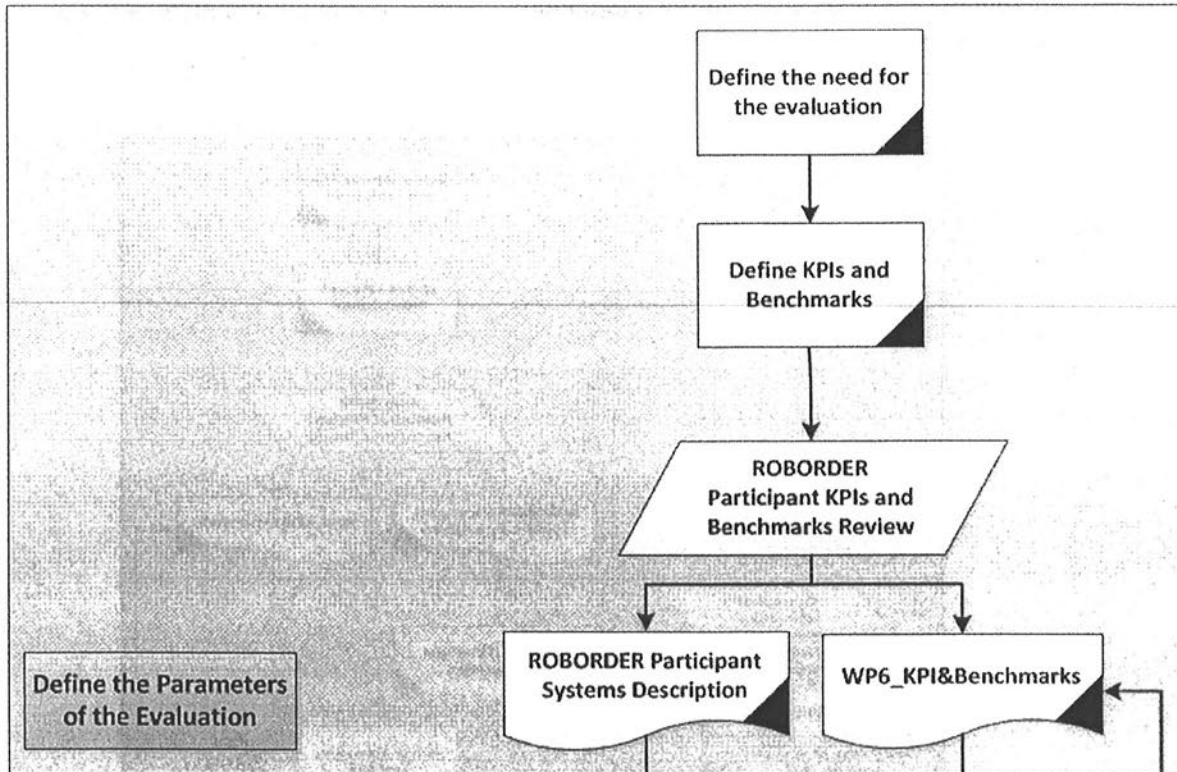

Figure 2 - Evaluation Methodology Phase 1

The identified KPIs can be divided into two main categories based on their application:

- **Functionality KPIs** are used to evaluate the performance of ROBORDER Platform modules. In this project the functionality KPIs are focused on the evaluation of the communication system, the autonomous systems, the detection and risk classification, localisation and tracking, and interception capability.
- **Operational KPIs** are used to evaluate the performance of the integrated ROBORDER Platform. In this case, the metrics refer to the overall capability of the ROBODER Platform to increase countermeasure effectiveness, safety, area coverage, and reduce manpower.

The ROBORDER Platform will strongly rely on autonomous systems; nonetheless, some actions will be made by human decision makers. For this reason, ROBORDER Platform operators have to be part of the metrics. This is underlined in tasks where the human machine interaction is relevant, such as countermeasure activation time. Due to the subjectivity introduced by the human presence, a testing framework is defined to limit arbitrary elements and to provide useful and consistent metrics for the ROBORDER Platform evaluation. The framework includes the possibility to perform tests for measuring trained user reaction times.

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A preliminary description of the ROBORDER Platform PUCs has been the initial data pool for defining the KPIs; specifically, their identification consisted in a series of consecutive steps:

1. Decomposition of the PUCs in elementary tasks;
2. Identification of tasks transversal to each PUC and tasks specific for single PUC;
3. Identification of metrics collectable during simulated and live demonstrations for each elementary task;
4. Definition of KPIs using the quantities identified in the step before. KPIs are defined in order to address functionality and operational performances of ROBORDER Platform;
5. Review of the KPIs to address reviewers' comments.

As already mentioned, the Evaluation Methodology will be used during both simulated and live demonstration tests; nonetheless the implementation of national KPIs will possibly make this methodology useful for the ROBORDER Platform operational life performance evaluation. To this end, depending on the metrics collected during the ROBORDER platform operative life, next versions of the KPI list might be split into two sets:

- Testing set;
- Real life operation set.

Phase 2: Design the methods used for the evaluation

A simulated testbed will be used to evaluate ROBORDER Platform performances (Figure 3). PUCs will serve as a reference set of tasks to be tested, while KPIs list will result in a list of metrics needed for the evaluation of system performances.
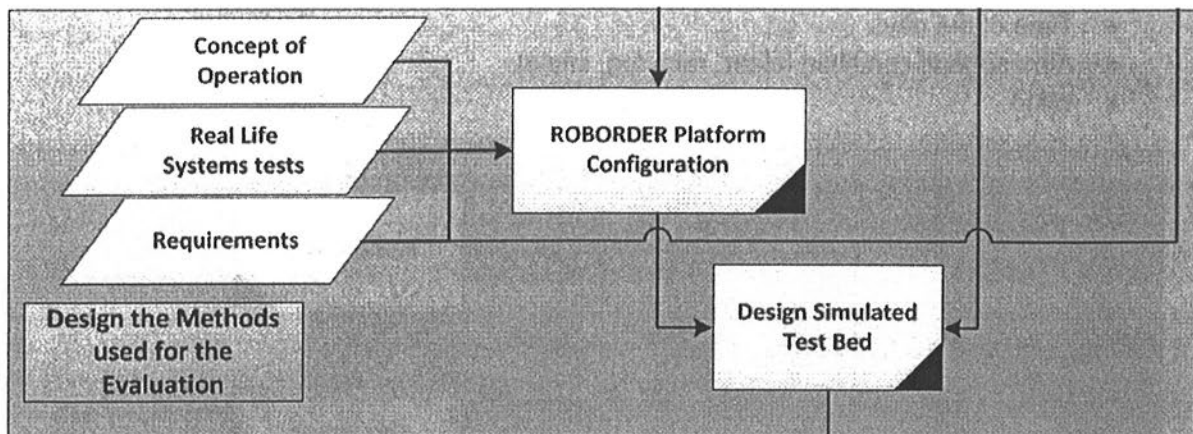
Figure 3 - Evaluation Methodology Phase 2

Modelling and Simulation (M&S) is the methodology proposed to provide the testbed capability to support the design and testing of the ROBORDER Platform Configuration.
The conceptual models for the simulated prototype of ROBORDER Platform will be based on historical data and the live demonstrations of the systems provided by the project participants, the developed concept of operations, and the list of requirements.

Simulation is currently used by some of the project partners for testing their components or solutions. The possibility to include M&S testing tools already present within the ROBORDER Consortium in the simulated testbed will be evaluated throughout a survey process.
The survey will be finalised by a catalogue in which each partner describes the available interoperable simulation with his salient characteristics. Even though this deliverable comes at an early stage of the catalogue definition it is possible to identify the main information contained in it:

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- Goal of the Simulation;
- Entities modelled;
- Parameters used to model the entities;
- Interoperability standard adopted;
- Federation Object Model or data exchange format (if available);
- Type of simulation (Live, Virtual, Constructive, Stochastic, Discrete Event).

Appropriate Verification, Validation and Accreditation (VV&A) procedures for the test bed simulated environment will be defined and followed to assure project objectives are reached and the required fidelity is achieved (IEEE 1516.4).

Phase 3: Collect evidence

The use of M&S should facilitate the data collection for the metrics.
In order to consider the effect of adverse weather, simulated tests shall be carried out in different weather conditions; the performances will be then compared. In particular it is suggested to agree with the users a shared definition on different levels of weather conditions (good, normal and bad) including day and night time, in which perform tests for the benchmarking. The testing activities will be carried out for each set of weather condition in order to understand the reliability and robustness of the ROBORDER configuration.

The following factors may be considered for the definition of the levels of weather conditions:

- Visibility;
- Temperature;
- Time of the day;
- Atmospheric condition (clear, rain, fog, snow);
- Wind
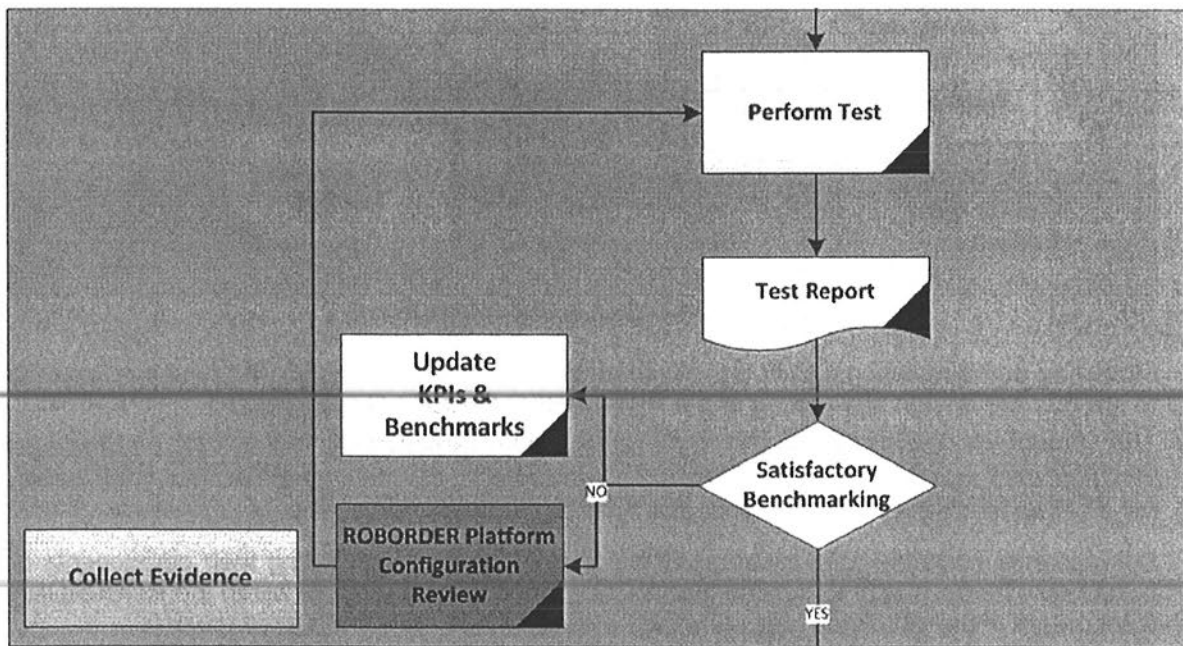
Figure 4 - Evaluation Methodology Phase 3

The simulated testbed will be used in an iterative way (Figure 4). In fact, the results of the tests will be collected in a Test Report. Performances, measured by KPIs, will be compared to the

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benchmarks established in phase one. The outcome of the test report shall lead either to the acceptance of the tested ROBORDER Platform configuration, or to its redefinition. Test report might also highlight the need to update KPIs and Benchmarks.

The evaluation methodology developed is sufficiently generic to be adopted for the evaluation of the live demo as well.

Phase 4: Report and Make Decisions

ROBORDER Platform evaluation shall be finalised by an Evaluation and Assessment Report (Figure 5). The report includes the description of the optimised ROBORDER Platform configuration and its performances for the defined PUCs.

Report and Make Decisions — **Evaluation & Assessment Report**

Figure 5 - Evaluation Methodology Phase 4

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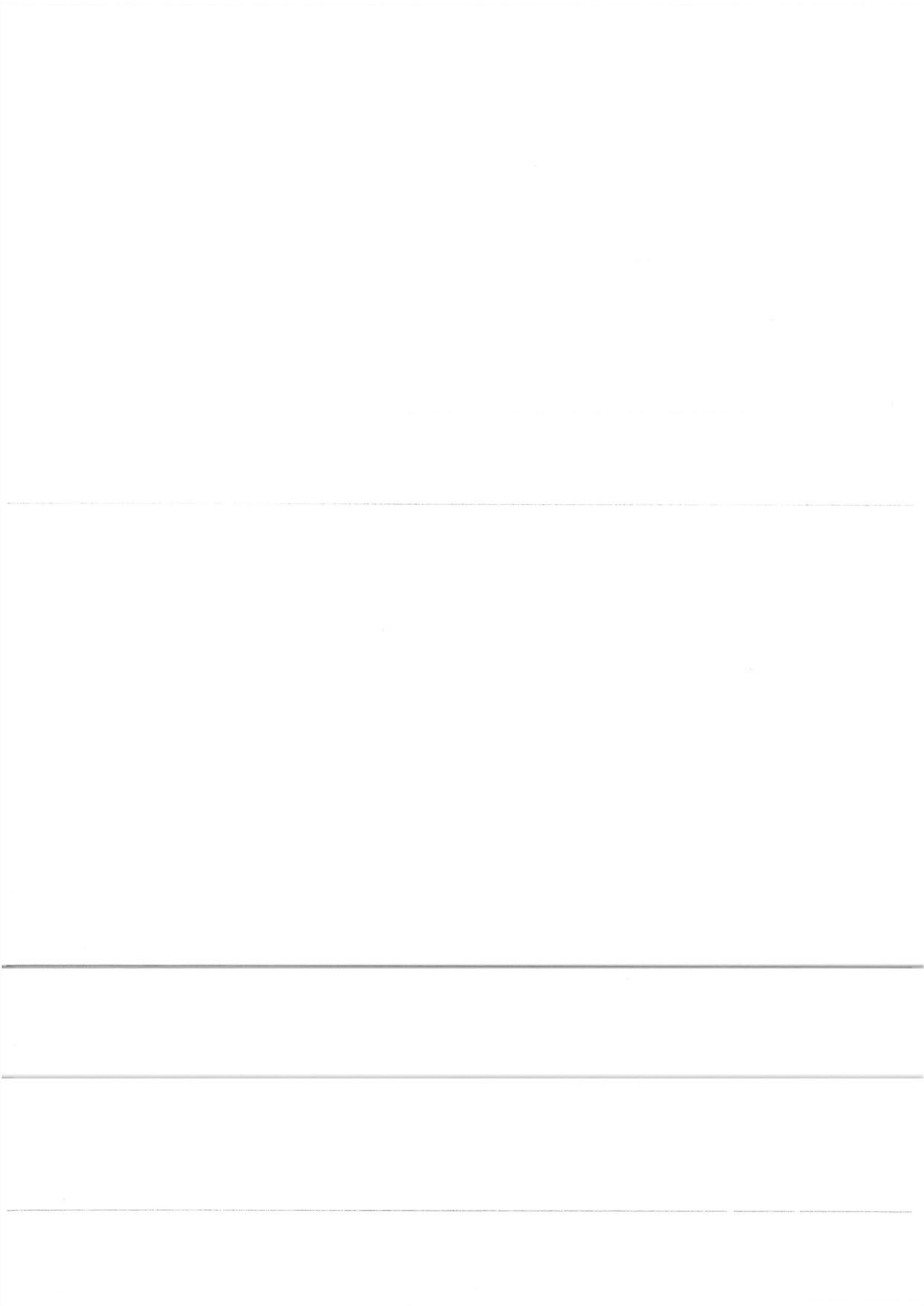
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3 KPIs Update

Since the first version of the KPI set has been reported in D6.1 in M6, the maturity of the ROBORDER platform changed significantly. The achievements from D6.1 delivery up to now include, among the others:

- ROBORDER requirements,
- Scenarios,
- Architectural design,
- Reviewers' recommendations.

Those informed the update of the KPI set; it has been hence possible to simplify the wide and generic KPI set provided at M6 (a very early moment of the project lifecycle), into a cogent and specific set presented in this document in Section 3.2.

The set presented has been accepted by ROBORDER end-user's leader, HMOD, as the reference set of KPIs for the project.

3.1 Table Structure

KPIs are provided in tables. Table 2 explains what the information contained in the table cells are.

Table 2 – Example of the KPI table

ID: Identification code of the KPI	KPI Name: Explicative KPI Name		
Category: Categories identified to map project objectives	Topic: Specific topic addressed by the KPI	PUC: The PUC for which the KPI is relevant	Objective: The project objective Presented in the Grant Agreement addressed by the KPI
Formula	Definition on how to compute the value of the KPI. The formula also identifies the metrics to be collected during the trials for computing the KPI.		

3.2 KPIs

The ROBORDER KPI set is reported in the tables in this section.

Table 3 – KPI_010: True Positive Detection Rate

ID: KPI_010	KPI Name: True Positive Detection rate		
Category: Situational awareness	Topic: Detection	PUC: All	Objective: IA2.1, IA2.2, IA2.3 IA2.4, IA2.5
Formula	(True Positive Detections)/ (Positive Detections)		

Table 4 – KPI_020: True Positive Detection Rate

ID: KPI_020	KPI Name: False Positive Detection rate		
Category: Situational awareness	Topic: Detection	PUC: All	Objective: IA2.1, IA2.2, IA2.3 IA2.4, IA2.5
Formula	(False Positive Detections)/ (Positive Detections)		

Table 5 – KPI_030: False Negative Detection Rate

ID: KPI_030	KPI Name: True Positive Detection rate		
Category: Situational awareness	Topic: Detection	PUC: All	Objective: IA2.1, IA2.2, IA2.3 IA2.4, IA2.5
Formula	(False Negative Detections)/ (Positive Detections)		

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Table 6 – KPI_040: Detection Precision

ID: KPI_040	KPI Name: Detection Precision		
Category: Situational awareness	Topic: Detection	PUC: All	Objective: IA2.1, IA2.2, IA2.3 IA2.4, IA2.5
Formula	(True Positive Detections)/ (True Positive Detections + False Positive Detections)		

Table 7 – KPI_045: Detection Accuracy

ID: KPI_045	KPI Name: Detection Accuracy		
Category: Situational awareness	Topic: Detection	PUC: All	Objective: IA2.1, IA2.2, IA2.3 IA2.4, IA2.5
Formula	(True Positive Detections + True Negative Detections)/ (Positive Detections + Negative Detections)		

Table 8 – KPI_050: True Positive Classification Rate

ID: KPI_050	KPI Name: True Positive Classification Rate		
Category: Situational awareness	Topic: Classification	PUC: All	Objective: IA2.1, IA2.2, IA2.3 IA2.4, IA2.5
Formula	(True Positive Classifications)/ (Positive Classifications)		

Table 9 – KPI_060: False Positive Classification Rate

ID: KPI_060	KPI Name: False Positive Classification Rate		
Category: Situational awareness	Topic: Classification	PUC: All	Objective: IA2.1, IA2.2, IA2.3 IA2.4, IA2.5: All
Formula	(False Positive Classifications)/ (Positive Classifications)		

Table 10 – KPI_070: False Negative Classification Rate

ID: KPI_070	KPI Name: False Negative Classification Rate		
Category: Situational awareness	Topic: Classification	PUC: All	Objective: IA2.1, IA2.2, IA2.3 IA2.4, IA2.5
Formula	(False Negative Classifications)/ (Positive Classifications)		

Table 11 – KPI_080: Classification Precision

ID: KPI_080	KPI Name: Classification Precision		
Category: Situational awareness	Topic: Classification	PUC: All	Objective: IA2.1, IA2.2, IA2.3 IA2.4, IA2.5
Formula	(True Positive Classifications)/ (True Positive Classifications + False Positive Classifications)		

Table 12 – KPI_090: Classification Accuracy

ID: KPI_090	KPI Name: Classification Accuracy		
Category: Situational awareness	Topic: Classification	PUC: All	Objective: IA2.1, IA2.2, IA2.3 IA2.4, IA2.5
Formula	(True Positive Classifications + True Negative Classifications)/ (Positive Classifications + Negative Classifications)		

Table 13 – KPI_100: Area Under Curve

ID: KPI_100	KPI Name: Area Under Curve		
Category: Situational awareness	Topic: Classification	PUC: All	Objective: IA2.2
Formula	Integral of the ROC Curve		

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Table 14 – KPI_110: Error Rate in Mission Control

ID: KPI_110	KPI Name: Error Rate in Mission Control[1]		
Category: Effectiveness	Topic: Interface	PUC: All	Objective: IA3.1
Formula	(Errors in mission control)/ (Total mission controls)		

Table 15 – KPI_130: Detection Latency

ID: KPI_130	KPI Name: Detection Latency		
Category: Situational Awareness	Topic: Time	PUC: All	Objective: IA3.5
Formula	|Time of Detection - Event Time|		

Table 16 – KPI_140: Classification Distance

ID: KPI_140	KPI Name: Error Rate in Mission Control[2]		
Category: Situational Awareness	Topic: Distance	PUC: All	Objective: IA3.5
Formula	|Classification position - Event position| at Classification time [m]		

Table 17 – KPI_150: Classification Latency

ID: KPI_150	KPI Name: Classification Latency		
Category: Situational Awareness	Topic: Time	PUC: All	Objective: IA3.5
Formula	|Time of Classification - Event Time|		

Table 18 – KPI_160: Mission Duration

ID: KPI_160	KPI Name: Mission Duration		
Category: Effectiveness	Topic: Time	PUC: All	Objective: IA3.3, IA3.5
Formula	|Event Time-Local Forces intervention time| [h]		

Table 19 – KPI_170: Scenario Coverage

ID: KPI_170	KPI Name: Scenario Coverage		
Category: Situational Awareness	Topic: Coverage	PUC: All	Objective: IA1.4, IA3.1
Formula	(Total Area Covered)/ (Scenario Area)		

Table 20 – KPI_180: Mission Coverage

ID: KPI_180	KPI Name: Mission Coverage		
Category: Situational Awareness	Topic: Coverage	PUC: All	Objective: IA1.4, IA3.1
Formula	(Total Area Covered)/ (Area assigned to be covered)		

Table 21 – KPI_190: Operator Capability

ID: KPI_190	KPI Name: Operator Capability		
Category: Situational Awareness	Topic: Coverage	PUC: All	Objective: IA1.4, IA3.1
Formula	(Total Area Covered)/ (Number of Operators) [m^2 per person]		

Table 22 – KPI_200: Operator Capability

ID: KPI_200	KPI Name: Area Coverage Effectiveness		
Category: Situational Awareness	Topic: Coverage	PUC: All	Objective: IA1.4, IA3.1, IA3.3
Formula	(Total Area Covered)/ (Personnel Involved) [m^2 per person]		

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[1] Only Demonstrated in Live Demos and Operational Tests
[2] Only Demonstrated in Live Demos and Operational Tests

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Table 23 – KPI_220: Failure

ID: KPI_220	KPI Name: Failure		
Category: Integration and Interoperability	Topic: Failure	PUC: All	Objective: IA5.1
Formula	ROBORDER Platform Mean Time Between Failures (MTBF) [h]		

Table 24 – KPI_230: Maintenance

ID: KPI_230	KPI Name: Maintenance		
Category: Effectiveness	Topic: Cost	PUC: All	Objective:
Formula	(Maintenance effort)/ (Area of border surveyed) [person-hour per square km]		

Table 25 – KPI_240: Operators

ID: KPI_240	KPI Name: Operators		
Category: Effectiveness	Topic: Cost	PUC: All	Objective:
Formula	(Operators effort + recon officers' effort)/ (Area of border surveyed) [person-hour per square km]		

Table 26 – KPI_250: Training

ID: KPI_250	KPI Name: Training[3]		
Category: Effectiveness	Topic: Cost	PUC: All	Objective:
Formula	Training Cost		

Table 27 – KPI_260: Procurement

ID: KPI_260	KPI Name: Procurement		
Category: Effectiveness	Topic: Cost	PUC: All	Objective:
Formula	Procurement Cost of the ROBORDER configuration		

Table 28 – KPI_270: Data Transmission

ID: KPI_270	KPI Name: Data Transmission		
Category: Effectiveness	Topic: Cost	PUC: All	Objective:
Formula	Data Transmission [Mbs]		

Table 29 – KPI_280: Autonomous Assets Balance

ID: KPI_280	KPI Name: Autonomous Assets Balance		
Category: Autonomy	Topic: Assets	PUC: 1-1, 1-2	Objective: IA5.1
Formula	(Number of Unmanned assets)/ (Number of Manned Assets)		

Table 30 – KPI_290: Signals

ID: KPI_290	KPI Name: Signals		
Category: Situational Awareness	Topic: Event	PUC: 1-2, 1-4, 1-7, 2-1	Objective: IA1.3, IA2.4, IA2.5
Formula	(Number of Signals Interceptions)/ (Number of Communications)		

Table 31 – KPI_300: Trespasser Number Detection

ID: KPI_300	KPI Name: Trespasser number detection		
Category: Situational Awareness	Topic: Event	PUC: 1-2, 1-3	Objective: IA2.2, IA2.3

[3] Only Demonstrated in Live Demos and Operational Tests

Formula	(Estimated Trespassers)/ (Actual Trespassers)

Table 32 – KPI_320: Flying Objects detection distance

ID: KPI_320		KPI Name: Flying Objects detection distance	
Category: Situational Awareness	Topic: Distance	PUC: 1-2, 1-3	Objective: IA3.5, IA1.2, IA2.2, IA2.3
Formula	|Flying object position - Detecting asset position| at Detection time [m]		

Table 33 – KPI_330: IR Camera detection distance

ID: KPI_330		KPI Name: IR Camera detection distance	
Category: Situational Awareness	Topic: Distance	PUC: 1-1, 1-2, 1-5, 1-8	Objective: IA1.2, IA2.2, IA2.3
Formula	|Event Position - IR camera position| at Detection time [m]		

Table 34 – KPI_340: Radar detection distance

ID: KPI_340		KPI Name: Radar detection distance	
Category: Situational Awareness	Topic: Distance	PUC: 1-1, 1-2, 1-6	Objective: IA1.2, IA2.2, IA2.3
Formula	|Event Position - Radar position| at Detection time [m]		

Table 35 – KPI_350: Humans detection distance

ID: KPI_350		KPI Name: Humans detection distance	
Category: Situational Awareness	Topic: Distance	PUC: 1-2, 1-3, 1-5, 1-8	Objective: IA1.2, IA2.2, IA2.3
Formula	|Humans position -Detecting asset position| at Detection time [m]		

Table 36 – KPI_360: Surface Vehicle detection distance

ID: KPI_360		KPI Name: Surface Vehicle detection distance	
Category: Situational Awareness	Topic: Distance	PUC: 1-1, 1-5, 1-6, 1-8	Objective: IA1.2, IA2.2, IA2.3
Formula	|Surface vehicle position -Detecting asset position| at Detection time [m]		

Table 37 – KPI_370: Underwater Vehicle detection distance

ID: KPI_370		KPI Name: Underwater Vehicle detection distance	
Category: Situational Awareness	Topic: Distance	PUC: 1-5	Objective: IA1.2, IA2.2, IA2.3
Formula	|Underwater vehicle position -Detecting asset position| at Detection time [m]		

Table 38 – KPI_380: Ground Vehicle detection distance

ID: KPI_380		KPI Name: Ground Vehicle detection distance	
Category: Situational Awareness	Topic: Distance	PUC: 1-5, 1-8	Objective: IA1.2, IA2.2, IA2.3
Formula	|Ground vehicle position -Detecting asset position| at Detection time [m]		

Table 39 – KPI_400: Oil Spill Detection

ID: KPI_400		KPI Name: Oil Spill detection	
Category: Situational Awareness	Topic: Event	PUC: 3-1	Objective: IA2.2
Formula	Minimum detectable oil spill surface		

Table 40 – KPI_410: UAV Endurance

ID: KPI_410		KPI Name: UAV Endurance	
Category: Integration and Interoperability	Topic: Endurance	PUC: All	Objective: IA5.1
Formula	|UAV launch - UAV recovery for low battery| [h]		

Table 41 – KPI_420: Assets IP

ID: KPI_420	KPI Name: UAV Endurance[4]		
Category: Integration and Interoperability	Topic: Environmental Resiliency	PUC: All	Objective: IA1.5
Formula	(Number of ROBORDER Assets that reach IP benchmarks)/ (Total Number of ROBORDER Assets)		

Table 42 – KPI_430: Carrier Battery Charging

ID: KPI_430	KPI Name: Carrier Battery Charging		
Category: Integration and Interoperability	Topic: Endurance	PUC: All	Objective: IA1.5
Formula	The amount of times the UAV battery can be charged in the carrier solution		

Table 43 – KPI_440: Carrier Endurance

ID: KPI_440	KPI Name: Carrier Endurance		
Category: Integration and Interoperability	Topic: Endurance	PUC: All	Objective: IA5.1
Formula	Overall autonomy of the UAV and Carrier [h]		

Table 44 – KPI_460: Workload

ID: KPI_460	KPI Name: Workload[5]		
Category: Effectiveness	Topic: Interface	PUC: All	Objective: IA3.1, IA3.6
Formula	NASA Task Load Index (TLX)[6]		

Table 45 – KPI_470: Usability

ID: KPI_470	KPI Name: Usability[7]		
Category: Effectiveness	Topic: Interface	PUC: All	Objective: IA3.1, IA3.6
Formula	System Usability Scale (SUS)[8]		

Table 46 – KPI_480: Persistency on the Area of Interest

ID: KPI_480	KPI Name: Persistency on the Area of Interest		
Category: Situational Awareness	Topic: Time	PUC: All	Objective: IA5.1
Formula	|Area of Interest surveillance end time - Area of Interest surveillance start time| [h]		

Table 47 – KPI_500: Deployment Volume

ID: KPI_500	KPI Name: Deployment Volume[9]		
Category: Effectiveness	Topic: Deployability	PUC: All	Objective: IA1.2, IA1.3, IA5.1
Formula	Size of the deployed systems [m^3]		

Table 48 – KPI_510: Deployment Weight

ID: KPI_510	KPI Name: Deployment Weight[10]		
Category: Effectiveness	Topic: Deployability	PUC: All	Objective: IA1.2, IA1.3, IA5.1

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[4] Only Demonstrated in Live Demos and Operational Tests
[5] Only Demonstrated in Live Demos and Operational Tests
[6] https://humansystems.arc.nasa.gov/groups/tlx/downloads/TLXScale.pdf
[7] Only Demonstrated in Live Demos and Operational Tests
[8] https://www.usability.gov/how-to-and-tools/methods/system-usability-scale.html
[9] For each asset
[10] For each asset

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Formula	Weight of the deployed systems [kg]

Table 49 – KPI_520: Border Operator Safety

ID: KPI_520	KPI Name: Deployment Weight		
Category: Effectiveness	Topic: Safety	PUC: All	Objective: IA3.1, IA3.5, IA3.6
Formula	Number of border surveillance officers placed in danger		

Table 50 – KPI_530: Success rate

ID: KPI_530	KPI Name: Success Rate		
Category: Effectiveness	Topic: Event	PUC: All	Objective: IA3.1, IA3.5, IA3.6
Formula	(Successfully addressed events) / (Total number of events)		

Table 51 – KPI_540: Effective use of working time

ID: KPI_540	KPI Name: Effective use of working time		
Category: Effectiveness	Topic: Time	PUC: All	Objective: IA3.1, IA3.5, IA3.6
Formula	(Border surveillance officer working time spent on duty at the border)/ (Overall working time)		

Table 52 – KPI_550: Communication Effectiveness

ID: KPI_550	KPI Name: Effective use of working time[11]		
Category: Effectiveness	Topic: Communication	PUC: All	Objective: IA3.1, IA3.5, IA3.6
Formula	Number of communications to address an event (e.g. emails, phone calls, VHF calls)		

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[11] Only Demonstrated in Live Demos and Operational Tests

3.3 Operator Performance KPIs

The process of updating the KPIs included interviews[12] and e-mail exchange with Project partners. The interviews with end-users were especially devoted to investigate what are the operators' performances they intend to affect/improve adopting ROBORDER.
It emerged that performances of interest are:

- Situational awareness, addressed by KPIs falling into the "Situational Awareness" Category: KPI_010, KPI_020, KPI_030, KPI_040, KPI_045, KPI_050, KPI_060, KPI_070, KPI_080, KPI_090, KPI_100, KPI_130, KPI_140, KPI_150, KPI_170, KPI_180, KPI_190, KPI_200, KPI_270, KPI_290, KPI_300, KPI_310, KPI_320, KPI_330, KPI_340, KPI_350, KPI_360, KPI_370, KPI_380, KPI_390, KPI_400, KPI_480.
- Time spent on active duty on the border: KPI_540;
- Communications needed to address events: KPI_550.

Further measure of operator performances is the effectiveness of using ROBORDER Interface, expressed both in terms of:

- Error rate in Mission Controls: KPI_110;
- Workload: KPI_460;
- Usability: KPI_470.

3.4 Cost KPIs

The following cost KPIs are identified:

- Maintenance effort: KPI_230;
- Operators effort: KPI_240;
- Training cost: KPI_250;
- Procurement cost: KPI_260;
- Data Transmission: KPI_270.

Maintenance and Operators costs are estimated in efforts [person-hour] (and then normalised by the border area) to avoid multi-currency issues and hour/cost difference from country to country. In the evaluation, a cost matrix will be provided to translate efforts in costs.
Operators include the LEAs (Law Enforcement Agencies) officers employed in patrolling duties.

3.5 TRL KPIs

KPIs for the improvement of TRL are reported below. This table is an update of Table 1.1 of the ROBORDER Grant Agreement. The table also include a link between components of the ROBORDER platform and the tasks they belong to.

Table 53 – TRL KPIs

KPI ID	KPI Name	Task	Current TRL	Expected TRL
TRL_1	Simulation Environment (SIMROB)	2.4	5	7
TRL_2	Extreme condition adaptability functionality	2.5	3	7
TRL_3	Passive Radar Receiver	2.2	4	7
TRL_4	Photonics-based radar	2.6	5	7

[12] Minutes are provided in ROBORDER Wiki at http://mklab.iti.gr/roborder/doku.php?id=wp6

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KPI ID	KPI Name	Task	Current TRL	Expected TRL
TRL_5	Optical clock for photonics-based radar network	2.6	4	7
TRL_6	Passive microwave sensors for mission-specific emission monitoring	2.3	5	7
TRL_7	Hierarchical cloudlet-based communication architecture	2.1	3	7
TRL_8	Context-aware link selection algorithm	2.1	3	7
TRL_9	Oil spill detection over sea surfaces	3.1	4	6
TRL_10	Radar Network Detection & Tracking	3.2	3	6
TRL_11	Visual Object Identification Module	3.2	5	7
TRL_12	Activity detection and recognition	3.2	4	6
TRL_13	Low-level fusion engine	3.3	5	7
TRL_14	Intrusion detection and classification module	3.4	4	6
TRL_15	SRD-based sensor of unauthorised communications for use on board unmanned vehicles	3.5	4	6
TRL_16	Novel Human-UxV interface	4.1	3	6
TRL_17	UxV Virtual Controller	4.3	3	7
TRL_18	"Plug-n-play" Resource Controller	4.3	5	7
TRL_19	Mission authoring tool	4.2	4	7
TRL_20	CISE-compliant representation framework	4.4	3	6
TRL_21	Semantic integration, reasoning and interoperation framework	4.4	5	7
TRL_22	Risk model framework	4.5	6	7
TRL_23	Decision support module (CERTH)	4.6	5	7
TRL_24	Visual analytics module (SHU)	4.6	3	6
TRL_25	Integrated and functional system	5	3	7

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3.6 PUCs Mapping

In the following table the KPIs are mapped against PUCs.

Table 54 – KPIs-PUC mapping

KPI ID	PUC 1-1	PUC 1-2	PUC 1-3	PUC 1-4	PUC 1-5	PUC 1-6	PUC 1-7	PUC 1-8	PUC 2-1	PUC 3-1
KPI_010	x	x	x	x	x	x	x	x	x	x
KPI_020	x	x	x	x	x	x	x	x	x	x
KPI_030	x	x	x	x	x	x	x	x	x	x
KPI_040	x	x	x	x	x	x	x	x	x	x
KPI_045	x	x	x	x	x	x	x	x	x	x
KPI_050	x	x	x	x	x	x	x	x	x	x
KPI_060	x	x	x	x	x	x	x	x	x	x
KPI_070	x	x	x	x	x	x	x	x	x	x
KPI_080	x	x	x	x	x	x	x	x	x	x
KPI_090	x	x	x	x	x	x	x	x	x	x
KPI_100	x	x	x	x	x	x	x	x	x	x
KPI_110	x	x	x	x	x	x	x	x	x	x
KPI_130	x	x	x	x	x	x	x	x	x	x
KPI_140	x	x	x	x	x	x	x	x	x	x
KPI_150	x	x	x	x	x	x	x	x	x	x
KPI_160	x	x	x	x	x	x	x	x	x	x
KPI_170	x	x	x	x	x	x	x	x	x	x
KPI_180	x	x	x	x	x	x	x	x	x	x
KPI_190	x	x	x	x	x	x	x	x	x	x
KPI_200	x	x	x	x	x	x	x	x	x	x
KPI_220	x	x	x	x	x	x	x	x	x	x
KPI_230	x	x	x	x	x	x	x	x	x	x
KPI_240	x	x	x	x	x	x	x	x	x	x
KPI_250	x	x	x	x	x	x	x	x	x	x
KPI_260	x	x	x	x	x	x	x	x	x	x
KPI_270	x	x	x	x	x	x	x	x	x	x
KPI_280	x	x								
KPI_290		x		x			x		x	
KPI_300		x	x							
KPI_310					x					
KPI_320			x		x					
KPI_330	x	x			x			x		
KPI_340	x	x				x				
KPI_350		x	x		x			x		
KPI_360	x				x	x		x		
KPI_370					x					
KPI_380					x			x		
KPI_390	x	x	x	x	x	x	x	x	x	x
KPI_400										x
KPI_410	x	x	x	x	x	x	x	x	x	x

KPI ID	PUC 1-1	PUC 1-2	PUC 1-3	PUC 1-4	PUC 1-5	PUC 1-6	PUC 1-7	PUC 1-8	PUC 2-1	PUC 3-1
KPI_420	x	x	x	x	x	x	x	x	x	x
KPI_430	x	x	x	x	x	x	x	x	x	x
KPI_440	x	x	x	x	x	x	x	x	x	x
KPI_450	x	x	x	x	x	x	x	x	x	x
KPI_460	x	x	x	x	x	x	x	x	x	x
KPI_470	x	x	x	x	x	x	x	x	x	x
KPI_480	x	x	x	x	x	x	x	x	x	x
KPI_490	x	x	x	x	x	x	x	x	x	x
KPI_500	x	x	x	x	x	x	x	x	x	x
KPI_510	x	x	x	x	x	x	x	x	x	x
KPI_520	x	x	x	x	x	x	x	x	x	x
KPI_530	x	x	x	x	x	x	x	x	x	x
KPI_540	x	x	x	x	x	x	x	x	x	x
KPI_550	x	x	x	x	x	x	x	x	x	x
TRL_1	x	x	x	x	x	x	x	x	x	x
TRL_2	x	x	x	x	x	x	x	x	x	x
TRL_3						x				
TRL_4						x				
TRL_5						x				
TRL_6	x	x	x	x	x	x	x	x	x	x
TRL_7	x	x	x	x	x	x	x	x	x	x
TRL_8	x	x	x	x	x	x	x	x	x	x
TRL_9										x
TRL_10	x	x	x	x	x	x	x	x	x	x
TRL_11	x	x	x	x	x	x	x	x	x	x
TRL_12	x	x	x	x	x	x	x	x	x	x
TRL_13	x	x	x	x	x	x	x	x	x	x
TRL_14	x	x	x	x	x	x	x	x	x	x
TRL_15	x	x	x	x	x	x	x	x	x	x
TRL_16	x	x	x	x	x	x	x	x	x	x
TRL_17	x	x	x	x	x	x	x	x	x	x
TRL_18	x	x	x	x	x	x	x	x	x	x
TRL_19	x	x	x	x	x	x	x	x	x	x
TRL_20	x	x	x	x	x	x	x	x	x	x
TRL_21	x	x	x	x	x	x	x	x	x	x
TRL_22	x	x	x	x	x	x	x	x	x	x
TRL_23	x	x	x	x	x	x	x	x	x	x
TRL_24	x	x	x	x	x	x	x	x	x	x
TRL_25	x	x	x	x	x	x	x	x	x	x

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3.7 Objectives Link

In the following table the links between KPIs and the ROBORDER objectives (Grant Agreement) are identified.

Table 55 – KPIs-PUC mapping

KPI ID	Objectives Reference
KPI_010	IA2.1, IA2.2, IA2.3 IA2.4, IA2.5
KPI_020	IA2.1, IA2.2, IA2.3 IA2.4, IA2.5
KPI_030	IA2.1, IA2.2, IA2.3 IA2.4, IA2.5
KPI_040	IA2.1, IA2.2, IA2.3 IA2.4, IA2.5
KPI_045	IA2.1, IA2.2, IA2.3 IA2.4, IA2.5
KPI_050	IA2.1, IA2.2, IA2.3 IA2.4, IA2.5
KPI_060	IA2.1, IA2.2, IA2.3 IA2.4, IA2.5
KPI_070	IA2.1, IA2.2, IA2.3 IA2.4, IA2.5
KPI_080	IA2.1, IA2.2, IA2.3 IA2.4, IA2.5
KPI_090	IA2.1, IA2.2, IA2.3 IA2.4, IA2.5
KPI_100	IA2.2
KPI_110	IA3.1
KPI_130	IA3.5
KPI_140	IA3.5
KPI_150	IA3.5
KPI_160	IA3.3, IA3.5
KPI_170	IA1.4, IA3.1
KPI_180	IA1.4, IA3.1
KPI_190	IA1.4, IA3.1
KPI_200	IA1.4, IA3.1, IA3.3
KPI_220	IA5.1
KPI_230	
KPI_240	
KPI_250	
KPI_260	
KPI_270	
KPI_280	IA5.1
KPI_290	IA1.3, IA2.4, IA2.5
KPI_300	IA2.2, IA2.3
KPI_320	IA3.5, IA1.2, IA2.2, IA2.3
KPI_330	IA1.2, IA2.2, IA2.3
KPI_340	IA1.2, IA2.2, IA2.3
KPI_350	IA1.2, IA2.2, IA2.3
KPI_360	IA1.2, IA2.2, IA2.3
KPI_370	IA1.2, IA2.2, IA2.3
KPI_380	IA1.2, IA2.2, IA2.3
KPI_390	IA2.2
KPI_400	IA2.1
KPI_410	IA5.1
KPI_420	IA1.5

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KPI ID	Objectives Reference
KPI_430	IA1.5
KPI_440	IA1.5
KPI_460	IA3.1, IA3.6
KPI_470	IA3.1, IA3.6
KPI_480	IA5.1
KPI_500	IA1.2, IA1.3, IA5.1
KPI_510	IA1.2, IA1.3, IA5.1
KPI_520	IA3.1, IA3.5, IA3.6
KPI_530	IA3.1, IA3.5, IA3.6
KPI_540	IA3.1, IA3.5, IA3.6
KPI_550	IA3.1, IA3.5, IA3.6
KPI_010	IA2.1, IA2.2, IA2.3 IA2.4, IA2.5
KPI_020	IA2.1, IA2.2, IA2.3 IA2.4, IA2.5
KPI_030	IA2.1, IA2.2, IA2.3 IA2.4, IA2.5
TRL_1	IA1.4
TRL_2	IA1.5
TRL_3	IA1.2
TRL_4	IA1.6
TRL_5	IA1.6
TRL_6	IA1.3
TRL_7	IA1.1
TRL_8	IA1.1
TRL_9	IA2.1
TRL_10	IA1.2
TRL_11	IA2.2
TRL_12	IA2.2, IA2.4
TRL_13	IA2.3
TRL_14	IA2.2
TRL_15	IA1.3, IA2.5
TRL_16	IA3.1
TRL_17	IA3.1
TRL_18	IA3.3
TRL_19	IA3.2
TRL_20	IA3.4
TRL_21	IA3.2
TRL_22	IA3.5
TRL_23	IA3.6
TRL_24	IA3.6
TRL_25	IA5.1