INDUSTRIAL RESEARCH

sesar JOINT UNDERTAKING

D12.3.950 - PJ14-W2-84c – TRL6 Contextual Note - Secured Surveillance Systems (Single and Composite Systems)

Deliverable ID:	**D12.3.950**
Dissemination Level:	**PU**
Project Acronym:	**PJ.14-W2-I-CNSS**
Grant:	**874478**
Call:	**H2020-SESAR-2019-1**
Topic:	**SESAR-IR-VLD-WAVE2-12-2019**
Consortium Coordinator:	**Leonardo**
Edition date:	**06 December 2022**
Edition:	**00.01.02**
Template Edition:	**02.00.04**

EUROPEAN PARTNERSHIP

Co-funded by the European Union

Authoring & Approval

Authors of the document

Beneficiary	Date
Thales	04 November 2022

Reviewers internal to the project

Beneficiary	Date
Thales	06 December 2022
Indra	06 December 2022
Eurocontrol	06 December 2022
Enaire	06 December 2022

Reviewers external to the project

Beneficiary	Date

Approved for submission to the S3JU By - Representatives of all beneficiaries involved in the project

Beneficiary	Date
Thales	06 December 2022
Indra	06 December 2022
Eurocontrol	06 December 2022
Enaire	06 December 2022

Rejected By - Representatives of beneficiaries involved in the project

Beneficiary	Date

Document History

Edition	Date	Status	Beneficiary	Justification
00.01.00	15 October	final	Thales	Version for submission to SJU
00.01.01	04 November	final	Thales	Version addressing SJU review comments
00.01.02	06 December 2022	final	Thales	Version addressing additional comments from maturity gate

EUROPEAN PARTNERSHIP

Co-funded by the European Union

Co-funded by the European Union

PJ.14-W2-I-CNSS

PJ.14-W2-84C - SECURED SURVEILLANCE SYSTEMS (SINGLE AND COMPOSITE SYSTEMS)

This Contextual Note is part of a project that has received funding from the SESAR3 Joint Undertaking under grant agreement No 874478 under European Union's Horizon 2020 research and innovation programme.

Abstract

This TRL6 Contextual note provides SESAR Solution PJ.14-W2-84c Secured Surveillance Systems (Single and Composite Systems) description for industrialisation consideration.

PJ.14-W2-84c covers the development of secured surveillance systems (focus on cooperative and cooperative dependent sensors) enabling the operational use of security functions.

The scope covers the sensor based radio frequency related threat detection and validation capabilities, performance assessment and identification of interoperable detection forwarding mechanisms by a specific ASTERIX target validation message.

With the specific objective to increase the maturity towards TRL6 a specific focus is laid on standardization including the ASTERIX target validation message (ASTERIX CAT 246).

Table of Contents

List of Figures

EUROPEAN PARTNERSHIP

Co-funded by the European Union

1 Purpose

This contextual note introduces the SESAR Solution PJ.14-W2-84c Secured Surveillance Systems (Single and Composite Systems) with a summary of the results stemming from R&D activities contributing to deliver it.

It provides to any interested reader (external and internal to the SESAR programme) an introduction to the SESAR Solution in terms of scope, main operational and performance benefits, relevant system impacts as well as additional activities to be conducted for increasing the level of maturity. This contextual note complements the technical data pack comprising the SESAR deliverables.

The project PJ.14-W2-84c is intended to develop secured surveillance with functionality enabling the detection, reporting and when possible mitigation of security threats of different nature that could affect the surveillance chain.

In previous activities, work was focused on the detection and indication and the analysis of metrics for the minimum detection and integrity performances that can be achieved by the different prototypes.

The objective in Wave 2 of SESAR 2020 is to evolve the current enabler CTE-S09 from a TRL4 to a TRL6 enabling the Performance Operational Improvement, POI-0059-SUR — Secured Surveillance Systems (Single and Composite).

EUROPEAN PARTNERSHIP

Co-funded by the European Union

2 Improvements in Air Traffic Management (ATM)

The SESAR solution “Secured Surveillance Systems (Single and Composite Systems)” is a technological solution that aims at enabling a Security functionality at Single and Composite (cooperative) surveillance systems such that safety of the surveillance system is maintained (safety through security). The focus laid on security threats evolving through the sensors RF-interface. In line with the underlying safety background a certain performance is deemed as necessary.

PJ.14-W2-84c substantiated material driving the security function performance requirements and assessment methods. Implemented security target threat validation information in the related prototypes technical specifications. Performed validation for TRL6 maturity of the prototypes.

This work is based on the activities from SESAR 15.4.2, 15.04.06 and SESAR2020 Wave1 PJ14-04-03 Task 05, which developed composite surveillance for WAM+ADS-B and secured surveillance for ADS-B at laboratory level.

Expansions for the Wave 2 for the TRL6 Validation covered specifically following additions:

- The key addition is the use of the ASTERIX target validation message ASTERIX CAT 246. This message was defined as a result of the TRL4 work where the lack of a standardised interface to report target validation information became apparent. The ASTERIX CAT 246 is still prototypic. The number was provided by the ASTERIX management group for the purpose of definition of a prototype. The specification for ASTERIX CAT 246 was prepared by DFS and is given in this document.

- The second relevant change is related to specific security performance requirements which have been established based on the results of the TRL4 validation in Wave 1.

ADS-B is envisaged as future surveillance backbone / allowing the use of ADS-B as own/independent surveillance layer also in high density airspace. The expected use of this solution is primarily in En-Route and TMA environments with potential application as well to airport environment. In consequence the focus will be laid to En-Route and TMA environment.

One of the main issues to be solved for ADS-B is related to potential security issues, namely validating the correctness of information provided by the aircraft prior to its use in ATC.

This solution aims to provide a system that is capable of resolving the potential ADS-B security related issues and enable a secure concept for its use in ER and TMA environment. It can also be applied to airport environments.

The application of the secured ADS-B as developed by this solution is seen to allow the use of ADS-B as independent surveillance layer also in high density airspace.

The operational use of ground surveillance sensors can be generalized as follows:

- Primary use of surveillance is to provide target locations via tracking system to a controllers Controller Working Position (CWP) who ensures aircraft separation

- Surveillance Systems Maintenance interface to technicians who supervise the system status and perform corrective actions in case of system status degradations

EUROPEAN PARTNERSHIP

Co-funded by the European Union

With respect to RF threats entering the surveillance chain at the sensor the following operational needs can be identified:

- ATCO needs a “clean“ display & reliable target positions
- But may need to be informed when the information becomes unreliable in order to adapt operation (for instance target position reporting by VHF)
- Tech Supervisor needs to be informed about system level threats – threats affecting the entire sensor/all targets
- A severe limitation to forward security related information currently exists, since there is no interoperable mean (e.e. ASTERIX category) to forward such information at target level. This drawback will be overcome with ASTERIX CAT-246 target validation message since it allows to forward detailed information on threats detected for a target.

In the context of RF-security the task of the sensor is to detect target and system related RF threats. At sensor level specific detection is feasible since the full RF related information is available. In downstream this information is lost – target information is more compressed.

The purpose of the (RF-) security function is to confirm the correctness (integrity) of (ADS-B) target data – especially the position and essential secondary surveillance data (like emergency status).

The role of the RF-security function in a ground sensor is to detect anomalies / security threats, to validate the correctness of the information and to forward information on target threat detections to downstream processing.

EUROPEAN PARTNERSHIP

Co-funded by the European Union

3 Operational Improvement Steps (OIs) & Enablers

POI-0059-SUR — Secured Surveillance Systems (Single and Composite): Secure Surveillance mechanisms/functions to enhance safety and improve information trustworthiness to the end users based on sensor radio frequency threat detection and validation capabilities.

CTE-S09 — Secured surveillance: Secured surveillance functionality by CTE-S09 enables the detection, reporting and when possible mitigation of security threats of different nature that could affect to the surveillance chain.

SVC-064 – Security Threats Detection, Service Enabler: Detection and reporting of security threats that might affect surveillance chain. Consists of two interfaces: SystemThreatDetection and TargetThreatDetection.

The purpose of the institutional enabler STD-110, ASTERIX CAT 246 transponder validation report is to provide a container for the provision of validation information regarding the behaviour of a specific transponder. As the plot is moving along the surveillance chain, beginning with its generation to its final processing by the SDPS providing the situation awareness, the CAT 246 report is designed to collect information provided by multiple systems. In addition to the provision of a specific validation result, a design goal for CAT 246 was to be able to preserve meta data (data describing data) e.g. the system identification which conducted a specific validation.

EUROPEAN PARTNERSHIP

Co-funded by the European Union

4 Background and validation process

The work performed by PJ.14-W2-84c represents a continuation of activities from SESAR 15.4.2, 15.04.06 and SESAR2020 Wave 1 PJ14-04-03 T05, which aimed on secured surveillance for ADS-B at laboratory level and proposed performance needs for secured surveillance systems.

In previous activities, work was focused on the detection and indication and initial analysis of metrics for the minimum detection and integrity performances that can be achieved by the different prototypes.

The next step, and the aim of this solution PJ.14-W2-84c, is to increase the maturity level of the enabler (CTE-S09) to a TRL6 by validating the security concept at Single and Composite (ADS-B+WAM) sensor level. This is achieved through verification that the defined threats are detected with required detection performance expressed by probability of detection, accuracy and Time-to-Alarm, with interoperable information on threat detection through ASTERIX CAT025 for system threats and ASTERIX CAT246 for target related threats and with required false alarm rate in case of absence of a threat, are achieved**.**

With the validation of the defined requirements it has been shown that the specified performance is feasible to be achieved with margins to accommodate for different operating environments., focussing on the detection of threats and alerts (intentional and non-intentional) detected by the systems. The exercise results have validated the technical requirements covered in D12.3.120 TS/IRS.

The validation was performed using the secured surveillance prototype installed on the platforms:

- THALES Lab Ditzingen
- Airport Erfurt (same as for solution PJ14-W2-84b)

The secured surveillance functions are identical for the Lab Testbed Ditzingen and the SUT installed at airport of Erfurt.

The major differences are the following:

- Surveillance function:
    - LAB Ditzingen: ADS-B only (centralized ADS-B system with capability to investigate single GS ADS-B as well)
    - Airport Erfurt: ADS-B + (Mini-MLAT)
- Traffic:
    - LAB Ditzingen covers En-Route & TMA (Airport Stuttgart)
    - Airport Erfurt covers: En-Route & TMA for ADS-B + TMA & ground for combined MLAT and ADS-B
- Threat injection:
    - THALES Lab Ditzingen allows to inject RF Threats to the SUT

EUROPEAN PARTNERSHIP

Co-funded by the European Union

    - Injection of RF-threats is not feasible at airport of Erfurt

- Embodiment in SUR-chain
    - Lab Ditzingen is not connected to a SDPS. The output data will be continuously logged and evaluated in post-processing
    - Airport Erfurt is connected to SDPS and CAT20, CAT21, CAT23 and CAT246 are forwarded
- Performance Parameter determination
    - Lab Ditzingen:
        - Detection capabilities based on injected threats
        - Time until threat is announced in CAT246
        - Determination of position deviations at trigger level & bit-error for essential data-fields
        - False Alarm rate based on long term data collection
    - Airport of Erfurt:
        - Determination of position deviations at trigger level & bit-error for essential data-fields
        - False Alarm rate based on long term data collection
        - Verification of CAT-246 Interoperability

The test means to inject threats are

- Raw data and threat scenario replay and RF-generation facility (Test-generator)
- Arbitrary waveform generator and RF signal generator
- GNSS simulator

The data collection and continuous evaluation means are

- Network attached storage, NAS (capacity expanded in Wave2)
- Data evaluation computer running continuous data evaluation with automatic daily report generation
- Computer with proprietary SW for post-processing analysis

EUROPEAN PARTNERSHIP

Co-funded by the European Union

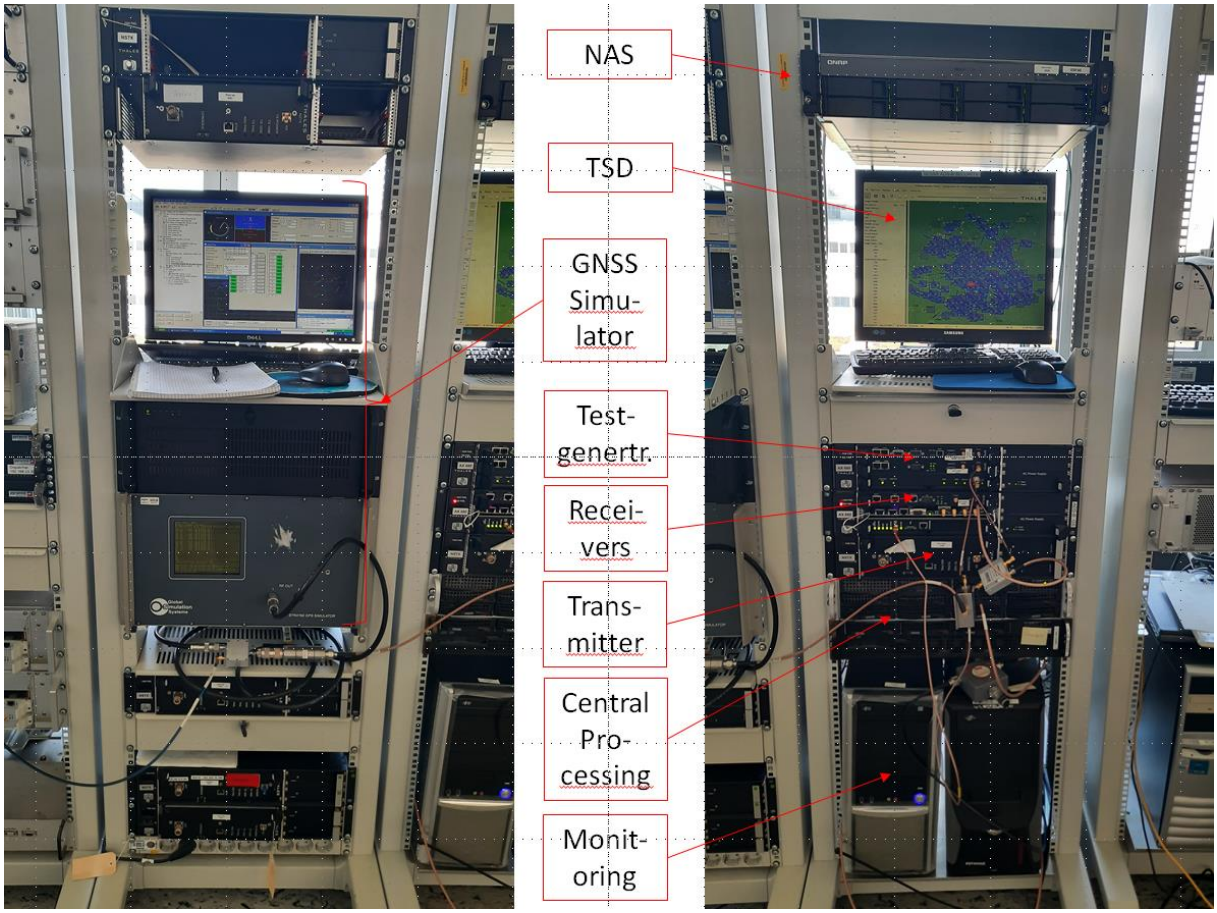

Figure 4-1: Lab Ditzingen SUT and Testequipment in laboratory

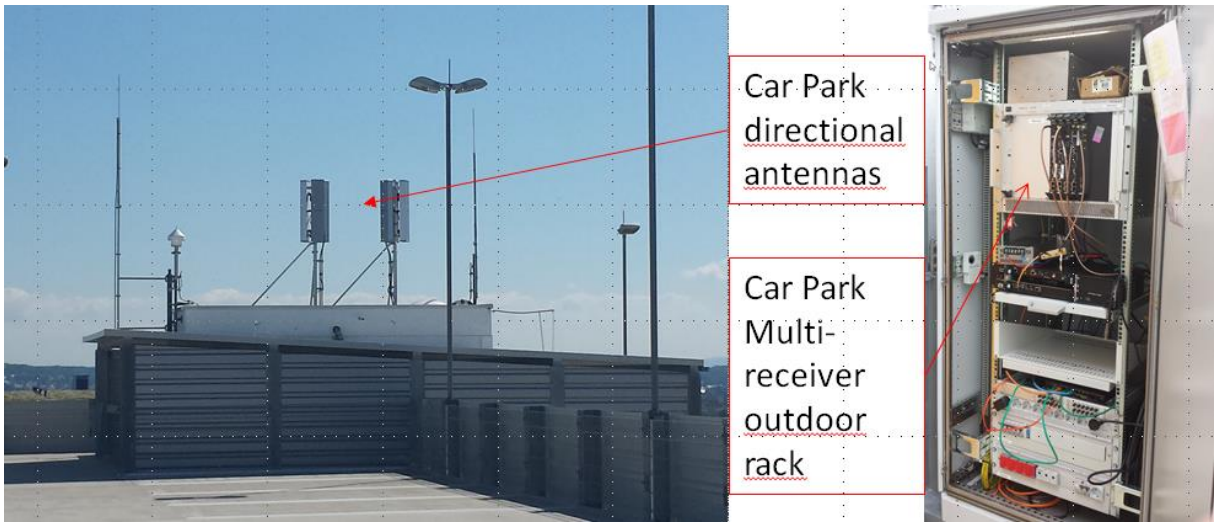

Figure 4-2: Lab Ditzingen SUT equipment on car park roof top

EUROPEAN PARTNERSHIP
Co-funded by the European Union

5 Results and performance achievements

SESAR Technological Solution 84c aims at validating the developed prototypes security functions capability of detecting the specified security threats with the defined performance and to forward detection information to downstream equipment in an interoperable manner via the specified ASTERIX categories.

The available results confirm the capability of the secured surveillance prototype to detect threats as defined. The verification of the detection capabilities was performed through scenario-based testing by LAB-Test Ditzingen and the Long-Term Assessment based on data recorded at the airport Erfurt test-bed.

The available results for the verification of the false alarm rate through long term assessment with in-field validation by the Erfurt Test-bed and the continuously operated LAB prototype in Ditzingen confirm the underlying requirement is fulfilled. The feasibility to achieve a sufficiently low false alarm rate and with it also the underlying requirement are validated.

The results for the verification of time until threat is announced by CAT-246 using the lab test-bed in Ditzingen are available. The feasibility to achieve a sufficiently low Time-to-Alarm and with it also the underlying requirement are validated.

Results for the determination of position deviations at trigger level & errors for essential data-fields were collected and are available. The feasibility to achieve a sufficient detection and with it also the underlying requirements are validated.

Results for the verification of ASTERIX CAT-246 interoperability with the test-bed at the airport of Erfurt and also with the LAB-Testbed-Ditzingen were collected and are available. The interoperability with ASTERIX CAT-246 and with it also the underlying requirements are validated.

Analysis of the achieved results against the defined performance values defined in TS/IRS confirms suitability of the secured surveillance to support the intended operation. Through this analysis the feasibility to detect the identified threats with a sufficient probability of detection, within a maximum Time-to-Alarm, with sufficient accuracy and with sufficiently small false alarm rate in case of absence of a threat and with it also the underlying requirements are validated.

The obtained results and an identified set of minimum requirements are expected to be used for future discussions with EUROCAE WGs involved in these activities. The new proposed ASTERIX category CAT246, target validation message has demonstrated to form an important mean to forward target threat detection and target essential ADS-B data and position validation data in an interoperable manner and is in consequence seen to form an input to standardisation through the ASTERIX Maintenance Group (AMG).

The Security Functionality and the validated Security Performance developed and obtained within this solution PJ.14-W2-84c, is demonstrated to be mature enough to achieve the targeted level of TRL6 for enabler CTE-S09 and the Performance Operational Improvement POI-0059-SUR.

Solution PJ.14-84c laid a strong emphasize to allow the use of the secured ADS-B as independent surveillance layer in high density airspace. In consequence the solution provides a path to achieve cost-savings through the use of ADS-B ground sensors.

6 Recommendations and Additional activities

The main recommendation is to pursue industrialization of solution. Secured surveillance provides a powerful mean to ensure correctness and validity of target data determined with ADS-B. Moreover, the position validation functionality allows to determine the location of potential spoofers and to forward their position.

At some point of time in the future the application of the ADS-B Phase Overlay (ADS-B version 3, see also solution PJ.14-W2-84d) is expected to be defined to authenticate ADS-B aircraft. However, the validation of target data and position is seen to form an essential part to ensure trust in the use of ADS-B data for air traffic control purposes (use to separate aircraft).

Co-funded by the European Union

7 Actors impacted by the SESAR Solution

The main actors impacted by the solution are:

- Industry (WAM/MLAT/ADS-B manufacturers):
  - Perform industrialization of the solution
  - Implement secured surveillance functionality into surveillance products
  -
- ANSPs deploying the system
  - Deploy secured surveillance in surveillance infrastructure
- ATC Maintenance personal
  - Maintain deployed secured surveillance infrastructure

EUROPEAN PARTNERSHIP

Co-funded by the European Union

8 Impact on Aircraft System

The solution does not affect to the Aircraft Systems.

EUROPEAN PARTNERSHIP

Co-funded by the European Union

9 Impact on Ground Systems

The main impact on Ground systems for this solution is the implementation of the new security functionalities for upgrading ADS-B, WAM and Composite (ADS-B and WAM) systems.

EUROPEAN PARTNERSHIP

Co-funded by the European Union

10 Regulatory Framework Considerations

A local certification according to applicable standards is expected.

EUROPEAN PARTNERSHIP

Co-funded by the European Union

11 Standardization Framework Considerations

The solution developed inputs, which are expected to be considered in future standards, namely:

- Standardise ASTERIX CAT-246: ASTERIX Maintenance Group.
- Standardise ADS-B RF-security and target validation by defining threats which have to be detected and the required detection & validation performance.
- Future updates of ED-129 and ED-142: To support the implementation of the solution compliance with the applicable ground equipment standards has to be demonstrated. It is expected that future revisions of ED-129x (MOPS for ADS-B ground equipment) and ED-142x (MOPS for wide area multilateration systems) reflect a security function.
- A proposed set of minimum number of requirements would have following general form:
    - ADS-B Security Detection requirement: Linked to Threats as per Eurocontrol GEN-SUR-SEC
    - Detection performance requirement: Linked to detection performance requirements expressed by probability of detection, accuracy and Time-to-Alarm as defined in D12.3.110 TS/IRS
    - False-Alarm-Rate requirement: Linked to false-alarm performance requirements expressed by probability of false alarm as defined in D12.3.110 TS/IRS
    - Information requirement: Linked to related ASTERIX (CAT023/CAT025 for system side and CAT246 for target side) categories to ensure interoperability

EUROPEAN PARTNERSHIP

Co-funded by the European Union

12 Solution Data pack

The solution data pack D12.3 - PJ14-W2-84c-TRL6-Data Pack Secured Surveillance Systems (Single and Composite Systems) of solution PJ.14-W2-84c Secured Surveillance Systems (Single and Composite Systems) will include:

- **D12.3.120 PJ14-W2-84c-TRL6- Final TS/IRS** – Secured Surveillance Systems (Single and Composite Systems), ed. 00.01.00, 07 December 2022: The technical specification (Final TS/IRS) defines functionality, interfaces and performance requirements for security functions of secured surveillance systems with the specific focus on cooperative and cooperative dependent surveillance ground sensors (ADS-B/WAM). These enable the operational use of these security functions. It covers the sensor based radio frequency related threat detection and validation capabilities, security function performance requirements (mainly in terms of missed detection and false alarm) and definition of interoperable detection forwarding mechanisms. Related to target threat detection forwarding a specific ASTERIX target validation message is proposed and included in this specification. Through the defined detection performance and interoperable interface definition the sensor based security functions are expected to allow the use of ADS-B as an independent surveillance layer in high density airspace.

- **D12.3.400 PJ14-W2-84c-TRL6- TVALR**- Secured Surveillance Systems (Single and Composite Systems),ed. 00.01.01, 26 October 2022: This document describes the Technical Validation Report for the SESAR Solution Pj.14-W2-84c – Secured Surveillance Systems (Single and Composite Systems), D12.3.400: TVALR. It describes the validation approach and the validation activities performed in order to validate the validation objectives associated to their corresponding success criteria and requirements. The requirements to be verified are defined in the Technical Specification D12.3.110Initial Technical Specification (TS/IRS). For each requirement or set of requirements, validation objectives are formulated. The validation approach including the validation exercises, with respect to scope, expectations and procedures, are provided for the validation objectives in the Technical Validation Plan D12.3.200.

- **D12.3.500 PJ14-W2-84c-TRL6- CBAT**- Secured Surveillance Systems (Single and Composite Systems, ed. 00.01.01, 04 November 2022: This document provides the **Technical Cost Benefit Analysis r**elated to SESAR Solution PJ.14-W2-84c addressing the secured surveillance systems. The objective is to set up the technological benefits related to this technological solution.

Co-funded by the European Union

Co-funded by the European Union