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ICARUS:

"Aviation-driven Data Value Chain for Diversified Global and Local Operations"

D5.2 – Demonstrators Execution Scenarios and Readiness Documentation

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Executive Summary

The ICARUS Deliverable D5.2 “Demonstrators Execution Scenarios and Readiness Documentation” aims at preparing the ICARUS demonstrators scenarios in order to ensure that they attach significant added value to the demonstrator partners from the 1st, 2nd and 3rd data value chain tiers and that they thoroughly verify and validate the ICARUS platform while showcasing its unique innovation potential in the aviation industry.

To this end, iterative brainstorming discussions were held within the consortium to appropriately position the ICARUS demonstrators in respect with the different ICARUS advancements, ranging from the ICARUS methodology phases to its MVP (Minimum Viable Product) and requirements. Overall, the ICARUS demonstrators are complementary and collectively leverage all the expected functionalities to be delivered in the ICARUS platform. In addition, a high-level plan for the demonstration activities was prepared in order to provide the rule of thumb for all demonstrators.

In summary, the 4 ICARUS demonstrators elaborated on 6 demonstration scenarios, that embrace over 20 interactions with stakeholders from the aviation data value chain, anticipate 37 test cases, involve 23 data assets that are currently available to the demonstrators and 24 data assets that need to be obtained with the help of ICARUS. The overall business context, the business objectives, the as-is and to-be processes are also identified. The business impact and expected benefits are put into context with the help of 20 key performance indicators, in total. Finally, the considerations, constraints and preconditions per demonstrator are discussed and the execution plan is detailed. It needs to be noted that there are some deviations on the demonstrators scenarios in respect to the ICARUS DoA yet they were necessary to ensure their feasibility and seamless execution within the project duration, considering their status at the moment the demonstration activities started and their data availability and needs.

The next steps related to this deliverable are the preparation of the necessary documentation of the ICARUS platform for the demonstrators’ training purposes, and the continuous monitoring and coordination of the execution of the demonstrators’ scenarios until the end of the project, according to their implementation plan. The outcomes of such activities will be reported in detail in subsequent deliverables in WP5 “ICARUS Data Value Chain Demonstration”.

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1 Introduction

1.1 Purpose

In alignment with the ICARUS DoA (Description of Action), the purpose of this deliverable D5.2 "Demonstrators Execution Scenarios and Readiness Documentation" is to conduct the necessary baseline activities for planning the smooth implementation of the demonstrators and setting up the necessary "environment" in each demonstrator site. The expected scenarios to run during each demonstrator are defined in this deliverable. Such scenarios aim at validating the ICARUS platform and at offering added value to specific processes and / or products of the demonstrators.

D5.2 is prepared as an outcome of the activities of the ICARUS task T5.2 "Demonstrators Baseline Activities, Operation Planning and Coordination", which is expected to continue its implementation in order to coordinate all demonstrator activities, prepare the necessary platform documentation and potentially identify new data, features and demonstration scenarios that will be executed in the upcoming demonstration runs.

1.2 Approach

The approach that was followed during the implementation of the ICARUS task T5.2 "Demonstrators Baseline Activities, Operation Planning and Coordination" included the following steps:

- *Step I: Brainstorming on the demonstrator descriptions* from the ICARUS DoA during the demonstrator-related discussions in the ICARUS plenary meetings during the 1st year.
- *Step II: Preparation of high-level guidelines* for the demonstrators in order to align their scenarios in terms of both timing and orientation related to how they practically utilize the ICARUS outcomes.
- *Step III: Iterative updates of the demonstrator scenarios* taking into account the prerequisite data availability and the subsequent status updates, as well the ICARUS offerings (as defined in the ICARUS methodology, MVP, architecture and the data-focused frameworks for data collection and safeguarding, data analytics and data sharing) and the expected added value and benefits for the demonstrator partners.
- *Step IV: Consolidation of the demonstrator scenarios* and detailed descriptions by the demonstrator partners, as well as definition of concrete key performance indicators (KPIs) to demonstrate the benefits by ICARUS.
- *Step V: Planning the demonstrators' scenarios* indicating the intermediate milestones and the expected outcomes per release.
- *Step VI: Preparation of the necessary documentation* regarding the ICARUS platform in order to appropriately train the demonstrator users and support them in implementing their demonstrators with the help of the ICARUS platform.

- *Step VII: Continuous monitoring and coordination* of the execution of the demonstrators until the end of the project.

This deliverable practically documents the outcomes from Steps I to V. The progress related to the forthcoming steps, VI and VII, will be documented in D5.3 (Demonstrators Operation Evaluation and Feedback–v1.00), D5.4 (Demonstrators Operation Evaluation and Feedback–v1.50) and D5.5 (Demonstrators Operation Evaluation and Feedback–v2.00).

1.3 Relation to other ICARUS Results

The activities documented in the ICARUS deliverable D5.2 are strongly related with the overall activities under WP5 "ICARUS Data Value Chain Demonstration": on the one hand, D5.2 takes into consideration the ICARUS Demonstrators and Platform Evaluation Framework that is reported in D5.1 when defining the demonstrators KPIs; on the other hand, D5.2 provides the handbook for all demonstration activities that will be reported in the various demonstrators' releases (in D5.3, D5.4, D5.5 and D5.6).

In order to define the scenarios in alignment with the different ICARUS results, D5.2 is based on the continuous data collection activities (initially reported in D1.1), the methodology and the MVP features (defined in D1.2), the demonstrator requirements and the overall platform architecture (described in D3.1), the data collection and safeguarding framework (elaborated in D2.1) and the data analytics and sharing framework (especially, the preliminary demonstrator's data analytics outlined in D2.2).

Finally, the concretization of the demonstrators' scenarios in D5.2 is expected to provide inputs to the updated report of the data collection activities (expected in D1.3), to the platform design and development activities (that run in WP3 and WP4, respectively) and to the overall exploitation and business case development activities in WP7.

1.4 Structure

This deliverable is structured in the following way:

- Section 1 introduces the scope and approach followed in the implementation of D5.2.
- Section 2 presents the overall demonstration baseline activities in ICARUS.
- Sections 3-6 define the business context, the demonstrator scenarios, the expected impact and execution plan for the AIA, PACE, ISI and CELLOCK demonstrators, respectively.
- Section 7 concludes this document and describes the next steps for the demonstration activities.

2 Demonstration Baseline Activities

2.1 ICARUS Demonstrators Positioning

The ICARUS platform shall be tested, evaluated and validated by four demonstrators that are representative of the three tiers of the aviation data value chain defined in ICARUS:

- **Demonstrator I**: **Airport capacity planning**. Demonstrator I handles primary aviation data (Data Tier 1) coming from an airport and is managed by AIA.
- **Demonstrator II**: **Enhanced routes analysis of aircraft for improved fuel consumption optimisation and pollution awareness**. Demonstrator II is placed in the intersection between Data Tiers 1 and 2 as it manages both primary aviation data of an aircraft and extra-aviation data (namely weather and environmental data). It is implemented by PACE/TXT.
- **Demonstrator III**: **Improved modelling of infectious disease spreading based on aviation's passenger data**. Demonstrator III combines data and knowledge from the Health domain (Data Tier 3) with primary aviation data (e.g. routes, types and number of passengers) and is executed by ISI.
- **Demonstrator IV**. **Enhancing inflight experience**. Demonstrator IV is focused on extra-aviation data (Data Tier 2) that are combined with primary aviation data (Data Tier 1) and is implemented by CELLOCK.

Figure 2-1: ICARUS Demonstrators Overview

Overall, the demonstrators will collectively put into use the different phases of the ICARUS methodology (defined in D1.2), ensuring its applicability to different scenarios to address the needs of different aviation-related stakeholders in a complementary manner. Table 2-1 presents how the demonstrators plan to address the different phases, with stronger green colour indicating High Interest and grey colour indicating an irrelevant phase for a demonstrator.

Table 2-1: Mapping of ICARUS Methodology (from D1.2) to ICARUS Demonstrators

ICARUS Methodology (D1.2)	Demonstrator I: AIA	Demonstrator II: PACE/TXT	Demonstrator III: ISI	Demonstrator IV: CELLOCK
I. Data Collection				
II. Data Enrichment				
III. Asset Storage				
IV. Asset Exploration & Extraction				
V. Data Analytics				
VI. Added Value Services				
VII. Service Collection				

Finally, when considering the different elements, namely aircrafts, passengers, baggage and cargo, that move through airports according to the IATA NEXTT initiative[1], the ICARUS demonstrators are related to the aircraft and passenger journeys.

2.2 Demonstrators High-level Plan

Although the demonstrators will individually set their detailed execution plan, a high-level plan has been constructed and needs to be followed to ensure that the demonstrators' outcomes are synchronized according to the ICARUS DoA. As depicted in the following figure, this high-level plan aims to coordinate the activities across T5.3 "Extra-Aviation Services in an Integrated Airport Environment", T5.4 "Routes Analysis for Fuel Consumption Optimisation and Pollution Awareness", T5.5 "Aviation Related Disease Spreading", T5.6 "Novel Airline Passenger Experience", as well as the cross-cutting T5.7 "Demonstrators Evaluation and Impact Assessment", and provide the demonstrators' feedback on time to the rest of the ICARUS activities.

In brief, three demonstrator releases are expected and exhibit the following features:

- An early demonstrator release (expected on M24) which showcases one demonstrator scenario utilizing the ICARUS platform with limited functionality.
- An intermediate demonstrator release (expected on M30) that complements and finalizes the early demonstrator release and initiates the rest of the demonstrator scenarios on the ICARUS platform.

[1] https://nextt.iata.org/

- An advanced demonstrator release (expected on M36), presenting the full implementation of demonstrator scenarios in the ICARUS platform.

Table 2-2: High-level Demonstrators Plan

High-level Demonstration Activities	M15*	M16*	M17*	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30	M31	M32	M33	M34	M35	M36
Preparatory Activity 1: Data Assets Gathering																						
Preparatory Activity 2: Data Assets Sharing within the Demonstrator																						
Preparatory Activity 3: Data Exploration / Experimentation with Analytics																						
Preparatory Activity 4: Training on the ICARUS platform																						
Implementation Activity 1: Set-up of ICARUS platform (e.g. on-premise client)																						
Implementation Activity 2: Run the expected test cases in the ICARUS platform																						
Implementation Activity 3: Integrate with demonstrators' back-end systems																						
Implementation Activity 4: Develop demonstrator's APIs / app (whenever applicable)																						
Implementation Activity 5: Define and measure the demonstrator's KPIs																						
Implementation Activity 6: Collect experiences and provide feedback																						

Since the first ICARUS platform release is expected on M18, the preparatory activities for the demonstrators, especially with regard to the data assets gathering and experimentation with algorithms, shall be conducted "offline" between the partners involved in each demonstrator for the early release only in order to ensure that the demonstrators will have some initial results as early as possible.

3 Demonstrator I: AIA

3.1 Business Context

The Athens International Airport (AIA) is the largest airport in Greece. Current passengers' traffic is about 24 million passengers while for 2019, it is forecasted at 25.3 million. The Total Air Traffic Movements (ATMs) for 2018 were counted to 216.000, with a prediction of 227.000 for 2019. The airport can accommodate every aircraft up to and including Boeing 747s and Airbus A380s. Overall, the Athens International Airport with its size of land, has room to grow.

As part of this original design, the Athens International Airport specified passenger volume "triggers" that would lead to a revision of the master plan and new construction to make sure it is able to meet the capacity needs. In this context, the Athens International Airport actually hit its first capacity threshold in 2008, which was a significant milestone. In addition, before hitting the 25 million passenger volume trigger, the airport is constructing an additional terminal which is expected to start its operation on June 2019, with new passenger gates, as well as improvements to the baggage handling system with the structure of a new building called TBF (Transfer Baggage Facility). The TBF (Transfer Baggage Facility) is planned to be in operation at the end of September 2019.

Currently, the airport has a total of 24 contact stands, out of which 14 contact stands are at the Main Terminal Building and 10 contact stands at the Satellite Terminal Building, and 89 remote stands. Figure 3-1 depicts the aircraft parking stand positions during a typical, operational day in summer in the form of a Gantt-like chart. In addition, the airport has a total of 20 contact passenger gates at the Main Terminal Building and 23 bus gates and 15 gates at the Satellite Terminal Building.

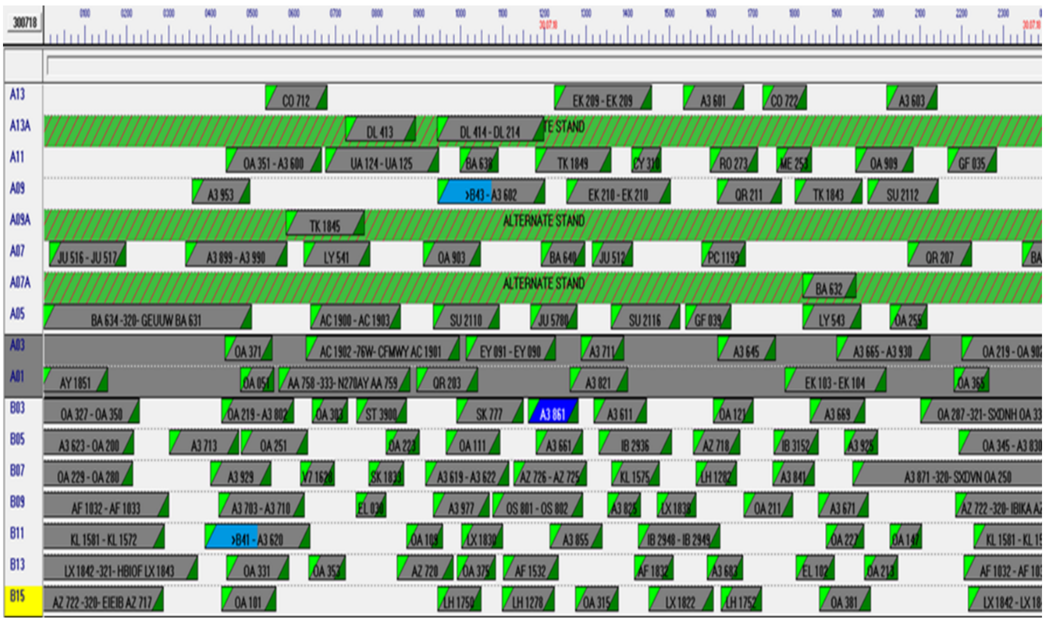

Figure 3-1: Gantt chart of the Aircraft Parking Stand positions within ASOC (Airport Services Operation Center) during an operational day of the summer

The capacity of the airport infrastructure (stands, gates vs planned aircraft arrivals) is generally adequate to meet the demands of the airport users at all times, but during a busy day and especially at peak hours, the demand exceeds the overall capacity of the airport and late arrivals or departures can create significant delays. As depicted in Figure 3-2, such cases typically appear in the morning and early afternoon.

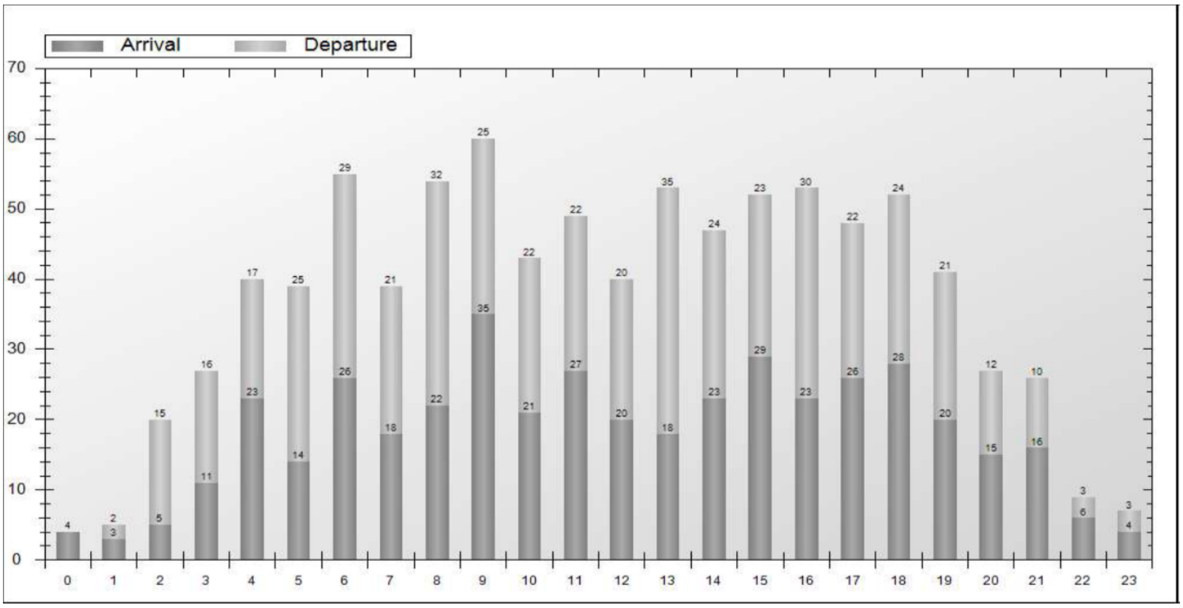

Figure 3-2: Arrivals and Departures distribution during a typical day of operations

So, the prime objective of the airport capacity planning is to ensure the most efficient use of the airport infrastructure, to achieve a sustained increase in throughput performance and to increase capacity in all weather conditions.

For the purposes of the airport coordination, airports are generally categorized by the responsible authorities according to the following levels of congestion:

- In a **Level 1 airport** (as the Athens International Airport), the capacity of the airport infrastructure is generally adequate to meet the demands of airport users at all times. The airport should monitor demand for the airport infrastructure and develop additional capacity when required to meet that demand. It is also responsible for working with handling agents and other agencies to avoid constraints that impact on airline operations. The airport managing body may request information from airlines on planned operations in specified formats. In some cases, it may appoint a data collection agent to undertake this task. It is the responsibility of the handling agent to make its own arrangements with the airport managing body to handle the planned operations. Handling agents have a major responsibility to ensure that unnecessary constraints are not created either through poor planning or inadequate resources in their own operations. In conclusion, being a Level 1 Airport enjoys multiple benefits:
    - The airlines operating or planning to operate are not obliged to submit details of their planned operations before operating at that airport.

    - The airport is not seeking to provide airside infrastructure to handle planned airline operations within agreed levels of service.
    - A process of slot allocation is not required.
- In a **Level 2 airport**, there is potential for congestion during some periods of the day, week or season, which can be resolved by scheduled adjustments that are mutually agreed between the airlines and the facilitator. All airlines operating or planning to operate at a Level 2 airport must submit details of their planned operations to the facilitator before operating at that airport. Airlines should be prepared to accept an alternative time if offered by the facilitator to avoid exceeding the coordination parameters, otherwise the airport may need to consider changing to Level 3. The airport must provide support to the facilitator in achieving full airline cooperation at Level 2 airports. It should provide the infrastructure necessary to handle planned airline operations within agreed levels of service. The airport must keep the facilitator and all interested parties informed about any capacity limitations, and especially give timely warning if one or more of these limitations might be reached or exceeded in the near future. Upon consultation with the related stakeholders, the airport must inform the facilitator of any capacity changes and of the coordination parameters. The facilitator will in turn inform the airlines.
- **A Level 3 airport** is an airport where: a) Demand for the airport infrastructure significantly exceeds the airport's capacity during the relevant period; b) Expansion of the airport infrastructure to meet demand is not possible in the short term; c) Attempts to resolve the problem through voluntary schedule adjustments have failed or are ineffective; and d) as a result, a process of slot allocation, according to which all airlines and other aircraft operators have a slot allocated by a coordinator in order to arrive or depart at the airport during the exact periods when the slot allocation occurs, is required. All airlines operating or planning to operate at a Level 3 airport must be allocated a slot by the coordinator before operating at that airport. Airlines should have adequate resources, expertise and systems to effectively participate in the coordination process. Because slots at a Level 3 airport may not be available at peak times, it is essential that airlines operating or planning to operate at that airport should be prepared to develop alternative plans if they are unable to obtain the slots they require. Some airports have few or even no suitable slots available. In these cases, airlines should be aware of alternative airports which could accommodate their planned operations.

The following figures depict different views of the aircraft allocation and departure sequence during peak hours.

Figure 3-3: Airport MTB Main Terminal Building aircraft allocation during peak hours

Figure 3-4: Airport MTB Main Terminal Building aircraft allocation during peak hours (wide bodies)

Figure 3-5: Morning departure sequence

3.2 Demonstrator Scenario: Airport Capacity Planning

The aim of the demonstrator is to enable capacity enhancement decisions that are directly targeted to the needs of the Athens International Airport, but shall also indirectly address interrelated problems that aviation stakeholders operating in AIA (such as airlines and ground handlers) currently face. In order to understand the current airfield performance and baseline capacity in AIA, and to properly perform an analysis that shall lead to improved planning of flight schedules per season, historical data for the runway, aprons, gates, aircraft stands, gates, terminals and local airspace (from all airport stakeholders and certified aviation organization sources) shall be leveraged together with aviation open data sources.

Through the ICARUS platform, AIA plans to run various descriptive and predictive analytics to address problems such as: Capacity Modelling, Airport Traffic Forecasting, Flight Delay Prediction, and Position and Slot Allocation / Scheduling, that are all interrelated to the core Airport capacity problem.

The expected benefit for AIA is to optimize the Airport airside capacity (including Aircraft parking stands and Passengers Gates) and improve the utilization of all airport airside infrastructure and improve the Runway Operations Capacity.

3.2.1 Current Challenges

The main challenge of the Athens Airport within the ICARUS project is to use big data technologies to analyse historical operational data, to detect the parameters that affect the operational processes and thus to improve the predictability and efficiency of the services offered.

The other challenge is related to trusted data sharing between airlines, control authorities, retailers and airports. In this case, airports could manage more efficiently all operational flows in and out of the terminal, in order to optimize the utilization of their infrastructure, strengthen security and of course, increase their revenues. The airport only owns between 5% and 20% of the data the aviation process generates, which is not satisfactory. According to a survey conducted by SITA (2018), 80% of airports and 50% of airlines would like to share data with each other, yet they still need to figure out what kind of data can be shared and try to reach an agreement between the airport and all relevant parties. Overall, the aviation industry faces increasing regulatory challenges for data sharing. It is thus imperative to overcome all arising difficulties in all planning phases of data sharing, in order for all operators to have access to high-quality information in a near real-time environment, on a platform connected to their backend systems, and to hopefully operate the airport more efficiently.

3.2.2 Business Objectives

The objective of the AIA demonstrator is to improve the overall airport capacity planning in an evidence-based, data-driven manner. With the help of the ICARUS platform, AIA addressed the **optimum airport capacity planning** problem to ensure the most efficient use of the airport infrastructure, to achieve a sustained increase in throughput performance and to increase capacity in all weather conditions. In particular, the demonstrator scenario will allow AIA to discover hidden patterns and implicit relations between operations and scheduling, and learn from the past experience in order to:

- Improve the planning of flight schedules per season with the airlines operating to AIA, by early identifying the airport's traffic high and low periods of time and through traffic forecasting at an hourly level.
- Achieve optimum utilization of ground services equipment in collaboration with ground handlers, through more accurate and timely predictions of future delays based on the airline, the route and the type of the aircraft, taking also into account the seasonality (day and time, as well) and the weather.
- Optimize the airport operation services by effectively scheduling the position and slot allocation, identifying the allocation of aircrafts to the existing positions and time slots (if necessary) at a given day.

3.2.3 Interaction with the Aviation Value Chain

In the case of the AIA "Airport Capacity Planning" scenario, the interactions with aviation stakeholders involve ground handlers, airlines and weather data providers as described in the following table.

Table 3-1: AIA Scenario Actors' Involvement

Level	Actor Type	Interaction Details
1	Airport	AIA will provide operational data for optimum capacity planning
1	Ground Handler	AIA will provide operational data exchanged with ground handlers through the airport data sets

Level	Actor Type	Interaction Details
1	Airline	AIA will provide operational data exchanged with airlines through the airport data sets
2	Weather Data Provider	Statistical weather data that are available as open data

3.2.4 Business Processes: AS-IS and TO-BE

The following table presents the business processes that are related to the "Airport Capacity Planning" scenario that AIA shall demonstrate in ICARUS, and refer to: (a) Improved planning of flight schedules per season, (b) Optimum coordination of ground services, (c) Optimization of airport operation services.

Table 3-2: AIA Scenario Business Processes

Scenario	**Airport Capacity Planning**
Business Process	**Improved planning of flight schedules per season**
AS-IS Situation (Before ICARUS)	**TO-BE Situation (With ICARUS)**
Match the current demand-needs to the available resources based on human experience Analyse capacity imbalance using historical data	Explore additional data that complement the available airport data Analyse capacity imbalance using historical airport data and additional data, and running descriptive and predictive analytics Calculate and visualize Capacity Metrics (hourly, daily, annual)
Business Process	**Optimum coordination of ground services**
AS-IS Situation (Before ICARUS)	**TO-BE Situation (With ICARUS)**
Match the current demand-needs to the available resources based on human experience	Explore additional data that complement the available airport data Analyse the use of Ground Services Equipment (GSE) and Human Resource for the optimum allocation, based on descriptive and predictive analytics
Business Process	**Optimization of airport operation services**
AS-IS Situation (Before ICARUS)	**TO-BE Situation (With ICARUS)**
Match the current demand-needs to the available resources based on human experience Analyse capacity imbalance using historical data	Explore additional data that complement the available airport data Analyse capacity imbalance using historical airport data and additional data, and running descriptive and predictive analytics Calculate and visualize Capacity Metrics (hourly, daily, annual)
Critical ICARUS Features	Critical platform features derived from the methodology in D1.2. • PLATF_F_02 Uploading of data assets as files extracted by the aviation stakeholder's back-end system • PLATF_F_12. (Semi-)Automatic extraction of concepts from within the Data Asset

	• PLATF_F_18 Searchability and identification of related additional data assets • PLATF_F_21. (Semi-)Automatic data asset linking • PLATF_F_22 Definition of simple and advanced "information" queries • PLATF_F_28. Navigation to preconfigured analytics • PLATF_F_31. Automatic check whether the data asset is appropriate for a specific algorithm • PLATF_F_34. Support for ICARUS variations of analytics algorithms, pre-trained for specific actions/insights • PLATF_F_35 Execution of an analytics task / algorithm according to specific preferences and settings for computation resources • PLATF_F_37. Comparison of the results of different algorithms • PLATF_F_38 Visualization of the analytics results to gain insights on the data and / or comparison how the same results are visualized in different diagrams • PLATF_F_39. Definition of customized dashboards by selecting which visualizations should appear • PLATF_F_41. Export of analytics results in machine-readable format (via an API, or as csv, json) • PLATF_F_42 Export of analytics reports as a downloadable file • PLATF_F_44. Execution of scheduled analytics • PLATF_F_48. Delivery of notifications regarding new data assets checked in, and/or existing data assets updated, related to own data assets or to analysis and visualisations performed • PLATF_F_51 Proposition of additional data assets for the enrichment of existing data assets and / or for analysis and visualisation • PLATF_F_57 Negotiation of a data sharing agreement

3.2.5 Test Cases

The following test cases are designed in such a manner that will effectively make use of different features of the ICARUS platform and particularly the related data analytics algorithms in order to achieve the intended business objectives and results that the Athens International Airport has set during the requirements definition phase. The test cases describe how the ICARUS platform is expected to be used and define the expected result following the completion of the demonstration scenario.

In particular, in the specific demonstrator scenario, there are the following 7 test cases:

- Securely upload confidential data assets
- Securely update already uploaded confidential data assets
- Create analytics tasks for each problem
- Search for additional data assets to complement the analysis
- Periodically run algorithms and save results

- Visualize the outcomes of the analysis
- Receive notifications when related data become available

The associated test cases are described in more detail in the following tables.

Table 3-3: AIA Scenario Test Case 1

Test Case	**Securely upload confidential data assets**
Actors	AIA as ICARUS user, ICARUS platform
Importance	High
Pre-conditions	User (and his/her associated organization, AIA) logged in to the ICARUS platform
Post-conditions	Airport data assets available in the AIA secure and private workspace in ICARUS
Workflow	1. Select option in the ICARUS platform to check in the AIA data sets 2. Browse for datasets file 3. Define and confirm how the AIA data match the ICARUS common aviation schema column-by-column. 4. Define the cleansing operations to be performed on the dataset 5. Define the columns of the dataset to which encryption needs to be applied. 6. Process the dataset locally. 7. Upload the encrypted file to ICARUS 8. Define the data access policies restricting access to the dataset for any stakeholder outside the AIA organization
Alternative Flows	2. Select a single or multiple csv file(s) 4b. Define the anonymization techniques to be applied on the dataset columns 7. Define the data license details
Related ICARUS Phase	Data Collection, Asset Storage
Success Indication	Data check-in terminates with success notification
Failure Indication	Data check-in aborts without failure notification
Notes	-

Table 3-4: AIA Scenario Test Case 2

Test Case	**Securely update already uploaded confidential data assets**
Actors	AIA as ICARUS user, ICARUS platform
Importance	High
Pre-conditions	• User (and his/her associated organization, AIA) logged in to the ICARUS platform • AIA flight schedule data already checked in in ICARUS
Post-conditions	Airport data sets updated with new information (e.g. new dates, updates on existing dates, etc.)
Workflow	1. Navigate to the data assets of AIA in ICARUS – note: they will be visible only by AIA 2. Select the data set(s) that need to be updated 3. Confirm the data cleansing, encryption and mapping functions already defined for the dataset. 4. Define the update currently performed.

	5. Select the location of the updated file. 6. Process the updated file locally. 7. Upload the updated encrypted file to ICARUS.
Alternative Flows	4a. Assist user with data update
Related ICARUS Phase	Data Collection, Data Enrichment, Asset Storage
Success Indication	Data set(s) update terminates with success message
Failure Indication	Data set(s) updates aborts without any notification or with a failure notification
Notes	-

Table 3-5: AIA Scenario Test Case 3

Test Case	**Create analytics tasks for each problem (Capacity Modelling, Flight Delay Prediction, Airport Traffic Forecasting, Position and Slot Allocation / Scheduling)**
Actors	AIA as ICARUS user, ICARUS platform
Importance	High
Pre-conditions	• User (and his/her associated organization, AIA) logged in to the ICARUS platform • AIA flight schedule data already checked in in ICARUS • Analytics algorithms available in ICARUS
Post-conditions	• Analytics workflows available for each problem and stored in ICARUS for future reference
Workflow	1. Decide on the analytics case/type 2. Define a new analytics workflow 3. Select analytics algorithms in the Analytics and Visualisation Workbench 4. Define the AIA data set(s) and any other related dataset(s) that are taken as input for the analysis 5. Define options and settings of analytics algorithm, if required 6. Save the analytics workflow as a private ICARUS application
Alternative Flows	2a. Predefined templates available for selection 3a. Select existing ICARUS apps that have already define analytics workflows and algorithms and replace the data with AIA data.
Related ICARUS Phase	Data Analytics
Success Indication	The definition of the analytics workflow terminates with success message
Failure Indication	Data analytics workflow definition aborts without any notification and without saving the analytics workflow.
Notes	-

Table 3-6: AIA Scenario Test Case 4

Test Case	**Search for additional data assets to complement the analysis**
Actors	AIA as ICARUS user, ICARUS platform
Importance	High

Pre-conditions	• User (and his/her associated organization, AIA) logged in to the ICARUS platform • AIA flight schedule data already checked in in ICARUS • AIA Analytics workflows already defined in ICARUS
Post-conditions	• Updated analytics workflows with additional data assets
Workflow	1. Access the ICARUS marketplace as a logged in user. 2. Query for additional data assets related to the analysis through different ways (e.g. selecting different keywords, columns a dataset must contain, the time period a dataset should cover, its applicable licence, etc.) 3. Navigate to the profiling of the related public and private available data set(s) in ICARUS and check their samples / extracts 4. Acquire/Purchase data set(s) that are relevant to the analysis at hand 5. Display data set(s) in the AIA private user space in ICARUS
Alternative Flows	2b. Check recommendations for related data assets 4b. Favourite data assets that may be of interest to AIA
Related ICARUS Phase	Data Exploration, Data Analytics, Asset Storage, Asset Sharing
Success Indication	Search terminates with additional data acquired
Failure Indication	Failure to find any related dataset(s) to complement the analysis
Notes	-

Table 3-7: AIA Scenario Test Case 5

Test Case	**Periodically run algorithms and save results**
Actors	AIA as ICARUS user, ICARUS platform
Importance	High
Pre-conditions	• User (and his/her associated organization, AIA) logged in to the ICARUS platform • AIA flight schedule data already checked in in ICARUS • AIA Analytics workflows already defined in ICARUS
Post-conditions	• Analytics results available in the AIA private and secure workspace in ICARUS
Workflow	1. Select analytics workflow in the Analytics and Visualisation Workbench 2. Define execution parameters (frequency of periodically running the workflow, the processing requirements, etc.) 3. Execute the analytics workflow in the AIA secure and private workspace in ICARUS 4. Receive notification when the analytics execution has finished 5. Review analytics results created in the AIA secure and private workspace in ICARUS 6. Encrypt and store results 7. Download results locally (in the On-Premise Environment) and decrypt them
Alternative Flows	4b. Monitor the analytics execution progress
Related ICARUS Phase	Data Analytics, Asset Storage, Asset Extraction, Notifications
Success Indication	Analytics results available in the AIA secure and private workspace in ICARUS
Failure Indication	Outdated or no results

Notes	-

Table 3-8: AIA Scenario Test Case 6

Test Case	**Visualize the outcomes of the analysis**
Actors	AIA as ICARUS user, ICARUS platform
Importance	High
Pre-conditions	• User (and his/her associated organization, AIA) logged in to the ICARUS platform • AIA flight schedule data already checked in in ICARUS • AIA Analytics workflows already defined in ICARUS
Post-conditions	• Available visualizations and dashboards for the AIA analytics
Workflow	1. Select analytics workflow in the Analytics and Visualisation Workbench 2. Define the visualization parameters (diagrams, axes titles, etc.) 3. Save the visualization dashboards in the analytics workflow 4. Access the dashboard when the analytics results are ready 5. Understand and evaluate the analytics results.
Alternative Flows	2b Predefined visualization dashboards/templates available for use
Related ICARUS Phase	Data Analytics
Success Indication	The visualisation dashboards render the results of the analysis as specified by the AIA user
Failure Indication	The visualisation dashboards fail to load without notification or do not correctly display results
Notes	-

Table 3-9: AIA Scenario Test Case 7

Test Case	**Receive notifications when relevant data become available**
Actors	AIA as ICARUS user, ICARUS platform
Importance	High
Pre-conditions	• User (and his/her associated organization, AIA) logged in to the ICARUS platform • AIA flight schedule data already checked in in ICARUS
Post-conditions	• Notifications received for other data assets that have been just uploaded to ICARUS and could be of interest to AIA
Workflow	1. Receive notification that a related data asset has been checked in in ICARUS 2. Access the profiling page of the specific data asset 3. Explore the data asset extract 4. Purchase the data asset 5. Navigate to the data and link them to the existing AIA data in the AIA secure and private workspace in ICARUS
Alternative Flows	4b. Favourite the data asset 4c. Ignore the data asset as it is not of interest to AIA

Related ICARUS Phase	Data Exploration, Data Enrichment, Notifications, Recommendations
Success Indication	Receipt of notifications for notifications that are relevant
Failure Indication	Related Data set(s) update notifications not received. Notifications for irrelevant data asset(s) received.
Notes	-

3.2.6 Data Availability and Needs

In order for the test cases to be successfully completed, the data sources that need to be used as inputs need to be available. It needs to be noted that some of the required data are already available and some will become available throughout the course of the project. The data availability and needs are summarized in the following tables and their criticality for the successful execution of the test cases is also assessed.

Table 3-10: AIA Scenario Data Available Overview

ID	Data Asset Title	Data Provider	Criticality
AIA_01	Time stamps and status of ground handling processes	Provided by the airline and the Ground Handler	High
AIA_06	Gate open time	Provided by the Airport	High
AIA_07	Flight Schedule	Airline	High
AIA_08	Flight Plans	Provided by the airline and handled by the ATC (Air Traffic Control) and Airport	High
AIA_09	Delays (technical or operational)	Provided by the airline and the Ground Handler	High
AIA_10	Availability and unavailability of airport Infrastructure (parking stands)	Provided by the Airport	High
AIA_11	ATC capacity (Aircraft touchdown / take off time, CTOT, TOBT, Minimum taxi time)	Provided by the ATC	High

Table 3-11: AIA Scenario Data Needed Overview

ID	Data Asset Title	Data Provider	Criticality	Status
AIA_DR_23	Aircraft Dimensions	Aircraft manufacturer, Open Data	Medium	To be available in ICARUS platform
AIA_DR_42	Actual national and international airport data library	Airports, OAG	Medium	To be available in

ID	Data Asset Title	Data Provider	Criticality	Status
				ICARUS platform
AIA_DR_43	Historical airport weather data at ground level	Open Data, AIA	High	To be available in ICARUS platform

More detailed information about the data available and needed is provided in the ICARUS Deliverable D1.1 "Domain Landscape Review and Data Value Chain Definition" and shall be updated in the forthcoming Deliverable D1.3 "Updated ICARUS Methodology and MVP WP1".

3.3 Considerations, Constraints and Preconditions

A precondition when comparing the airport capacity and essentially flight schedules from different seasons - on a year to year basis - is to try to compare flight schedules that are as identical as possible – in terms of flights, aircrafts and destinations - so as to be able to safely reach credible conclusions. For the evaluation of the impact of the ICARUS platform, a baseline thus needs to be produced so that a comparison of the KPIs before and after the implementation of the ICARUS platform can be made. The comparison refers to the flight schedule, the allocation of airport resources and the subsequent capacity achieved.

As the above precondition is very difficult to be achieved, since the aviation industry is a very dynamic industry, adjustments will need to be made to the outcome of the analysis before and after the implementation of the ICARUS platform. More respectively the percentage change of various variables such as volume of flights, type of flights (domestic, international), types of aircrafts (capacity, MTOW, dimensions etc.), special requirements (such as security or boarding and parking preferences) will be taken into consideration when trying to deduce the outcome of the analysis.

The evaluation of the results before and after the implantation of the ICARUS platform and the respective analysis will take place for a given period of the flight schedule and especially for problematic days of operation and periods. It will be checked to what extent the flight schedule with the use of the ICARUS platform provides the intended benefits.

3.4 Business Impact and Expected Benefits

With the help of the ICARUS platform, AIA expects to further embrace data-related technologies and increase its overall data readiness in terms of data sharing and data analytics. ICARUS will offer aviation-related data from various sources and shall help AIA to increase its data reach in an effortless manner, by finding and exploring additional data "on-the-go" while performing or trying to improve an analysis. Through its experimentation in ICARUS, AIA may thus reach bilateral data sharing agreements between the airport and its relevant parties with less effort and in less time, in order to complement its data availability with different data assets that have been identified and could be leveraged by the airport in scenarios beyond the airport capacity planning. In addition, AIA will significantly benefit from ICARUS in transitioning to the Artificial Intelligence era, by augmenting its baseline data analysis that is already performed in its IT infrastructure with advanced machine learning and deep learning analytics to improve its operational efficiency.

AIA eventually expects to strengthen its win-win collaborations with relevant aviation stakeholders (i.e. airlines and ground handlers) through the provision of renovated, or even new data-driven intelligence services as emerging from its demonstrator results. Overall, the outputs of the AIA demonstrator in ICARUS are expected to generate added value to the operations of various involved parties, such as:

- For the AIA operations: Better capacity planning, better readiness in addressing seasonality demands, improved airport operations scheduling.
- For airlines: Eventually better coordination with AIA for planning the flight schedules per season based on the AIA demonstrator analytics.
- For ground services: Optimized, short-term coordination of ground services with AIA taking into account the projected delays, based on the AIA demonstrator analytics.

Table 3-12: AIA Key Performance Indicators

Scenario	KPI	Calculation Method	AS-IS Value	TO-BE Value	Verification Means
1	Increase of advance time for average delay time prediction	[[Time to predict average delay time with ICARUS] - [Time to predict average delay time based on current business practices]] / [Time to predict average delay time based on current business practices]	-	30%	Comparisons of actual data already available from the Airport with the ICARUS predictions
1	Increase of advance time for identifying delay codes related to airport reasons	[[Time to predict delay codes with ICARUS] - [Time to identify delay codes based on current business practices]] / [Time to identify delay codes based on current business practices]	-	30%	Comparisons of actual data already available from the Airport with the ICARUS predictions
1	Increase of prediction accuracy for airport peak arrival /	[[Prediction accuracy with ICARUS] - [Prediction accuracy based on current business practices]] / [Prediction accuracy	-	10%	Selection of comparable historical data for the airport's traffic high and low periods at hourly / daily / seasonal level

Scenario	KPI	Calculation Method	AS-IS Value	TO-BE Value	Verification Means
	departure capacity	based on current business practices]			Comparison of in-house analytics predictions already available in the Airport with the ICARUS predictions
1	Reduction of time to forecast the availability of aircraft parking stands	[[Time to forecast based on current business practices] - [Time to forecast with ICARUS]] / [Time to forecast based on current business practices]	-	15%	Comparisons of in-house analytics predictions already available in the Airport with the ICARUS predictions
1	Evidence based substantiation of empirical operational knowledge	Sum of patterns and rules related to airport capacity, found through the ICARUS analysis	-	+15	Count of new patterns and rules found through ICARUS that were not already known in the airport

3.5 Demonstrator Execution Plan

The AIA demonstrator plan is consistent with the high-level plan defined for all demonstrators in section 2.2 and anticipates the following activities per release:

- In the early demonstrator activities (expected to be completed on M24), the baseline activities for Capacity Modelling & Forecasting (across all business processes: (a) Improved planning of flight schedules per season, (b) Optimum coordination of ground services, (c) Optimization of airport operation services) will be performed. Essentially, they include data assets collection, exploration and experimentation with different analytics algorithms in the early ICARUS platform release. At the same time, the preliminary results for flight delay prediction to contribute to the optimum coordination of ground services will be showcased and evaluated.
- The demonstrator activities for the intermediate release (expected to be completed on M30) also anticipate data assets collection, exploration and experimentation with different analytics algorithms in subsequent ICARUS platform releases. Updates are expected on the baseline activities for Capacity Modelling and the flight delay prediction analytics while early results for the improved planning of flight schedules per season are also expected.
- The advanced demonstrator release (expected to be completed on M36) will present the full implementation of the AIA demonstrator scenario in the ICARUS platform, leveraging the full data sharing and analytics functionalities and finalizing the experimentation with all analytics algorithms (including the Position and Slot Allocation / Scheduling that will be introduced in this iteration).

Table 3-13: Demonstration Activities for AIA

Demonstration Activities	M15	M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30	M31	M32	M33	M34	M35	M36
I.1 Data Asset Gathering and Sharing																						
I.2 Data Asset Exploration																						
I.3 Data Analytics Experimentation and Execution																						
I.3.1 Baseline analytics for Capacity Modelling																						
I.3.2 Analytics towards optimum coordination of ground services																						
I.3.3 Analytics towards improved planning of flight schedules per season																						
I.3.3.4 Analytics towards optimization of airport operation services																						
I.4 ICARUS Platform and AIA Demonstrator Evaluation																						

4 Demonstrator II: PACE

4.1 Business Context

Cutting operational expenses while reducing environmental impacts will certainly become among the top challenges of the aviation industry in the next decade. The success of this objective requires improvements not only in the use of resources and materials but also methods and tools. In this context, the Pacelab Mission Suite is a commercially available software solution for route analysis, aircraft performance and economic investigations.

Flexible analysis options support assessing the economic viability of route network extensions or modifications and deliver reliable projections of operational key metrics such as block time, block fuel and payload capacity. Today the Pacelab Mission Suite already delivers benefits for a wide range of aviation industry stakeholders, including but not limited to aircraft manufacturers' marketing and sales departments, airlines' fleet and route network planning departments as well as aircrafts' leasing and financing institutions.

The Pacelab Mission Suite allows the definition of the aircraft in terms of characteristic weights and flight profile performance as depicted in Figure 4-1. Moreover, the users have access to a library of aircraft models including high-speed performance data tables estimated with the Pacelab APD software.

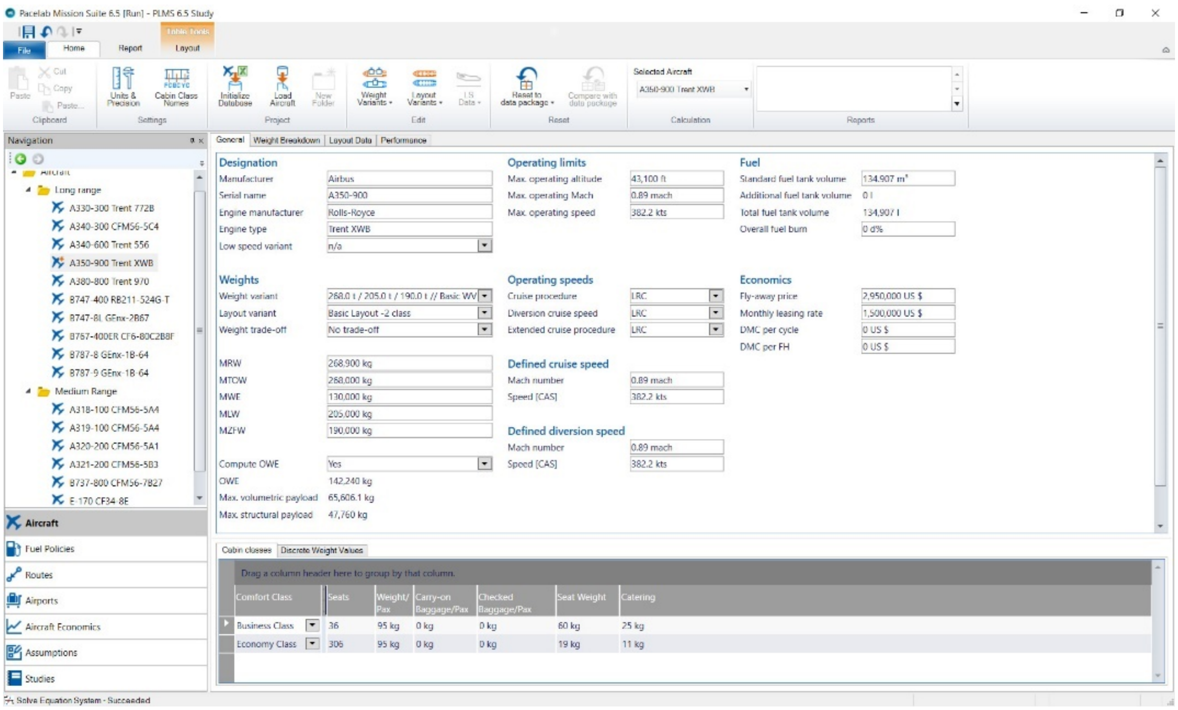

Figure 4-1: Pacelab Mission Suite - Aircraft Definition Model Library

In the style of a modern spreadsheet application, the Pacelab Mission Suite provides a fully featured grid view for defining and editing routes, route networks and multi-hop (non-refuel) legs as depicted in Figure 4-2.

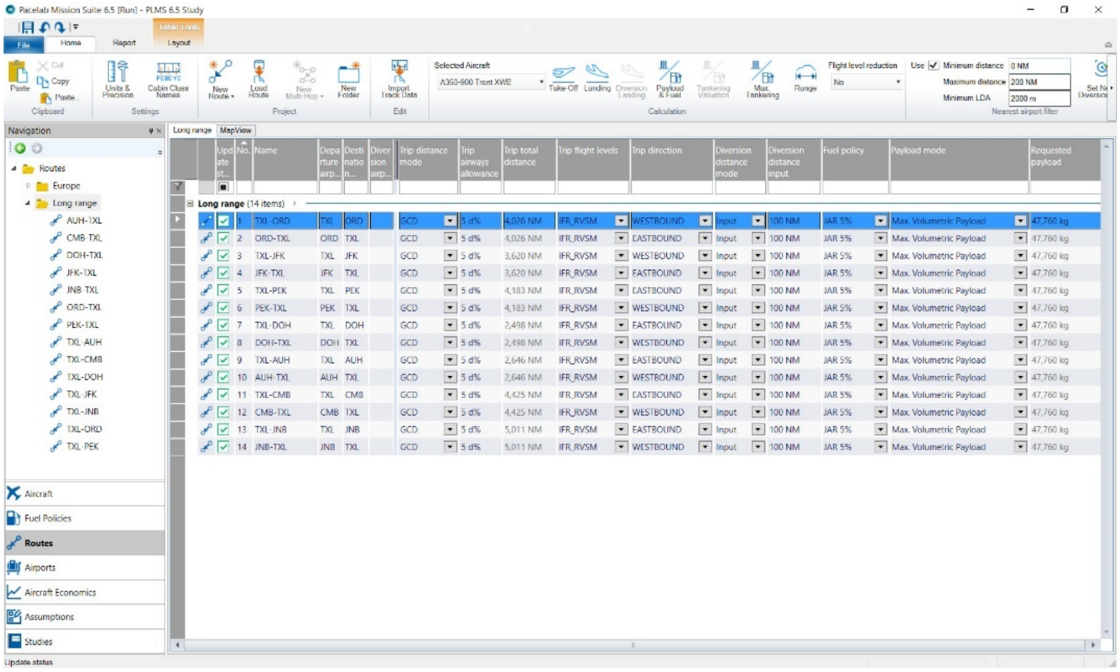

Figure 4-2: Pacelab Mission Suite - Routes Network Definition

Furthermore, the Pacelab Mission Suite provides an online map view (as in Figure 4-3), based on OpenStreetMap for reviewing and sharing routes, route networks and range circles, e.g. for embedding images in Microsoft PowerPoint. In addition, users have access to a library of airports including a representative selection of national and international airports.

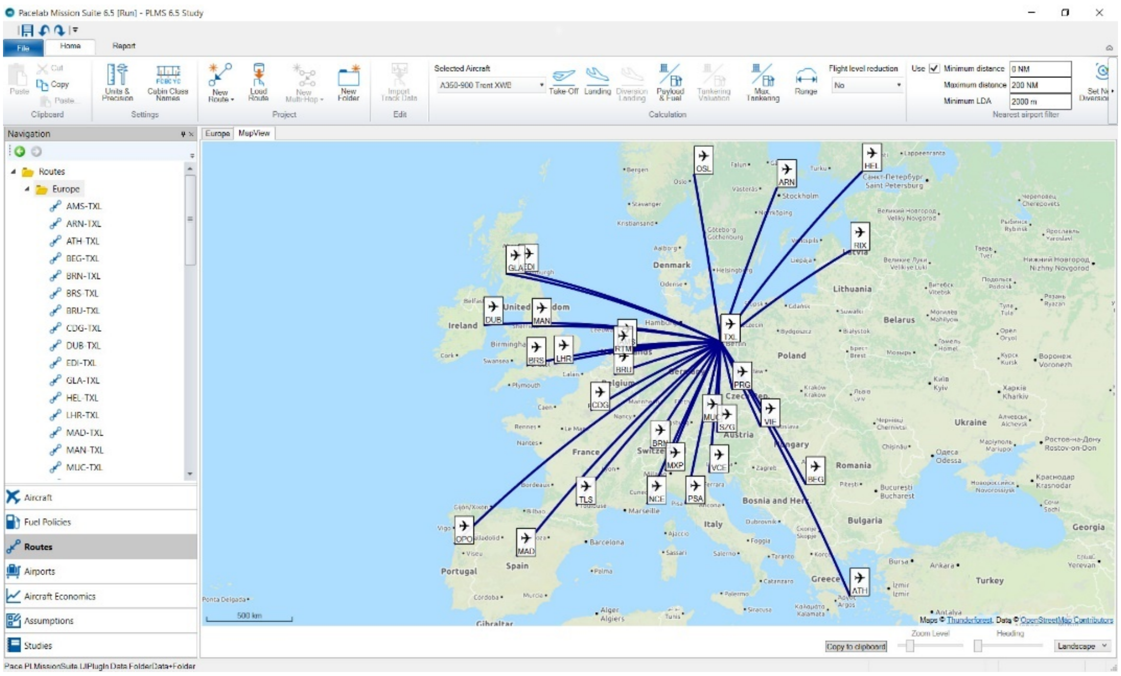

Figure 4-3: Pacelab Mission Suite - MapView

The Pacelab Mission Suite supports a wide range of flight performance calculations, including but not being limited to maximum payload vs. minimum fuel, take-off and landing, maximum range, re-clearance, ETOPS, fuel tankering scenarios and aircraft economics. For this purpose, users can graphically define complex vertical flight profiles and detailed standard international and non-standard reserves policies. Optionally an economics module can be included which enables direct and cash operating cost investigations and complex trade studies, e.g. for competitive aircraft analysis involving multiple aircraft models, as shown in the following figures.

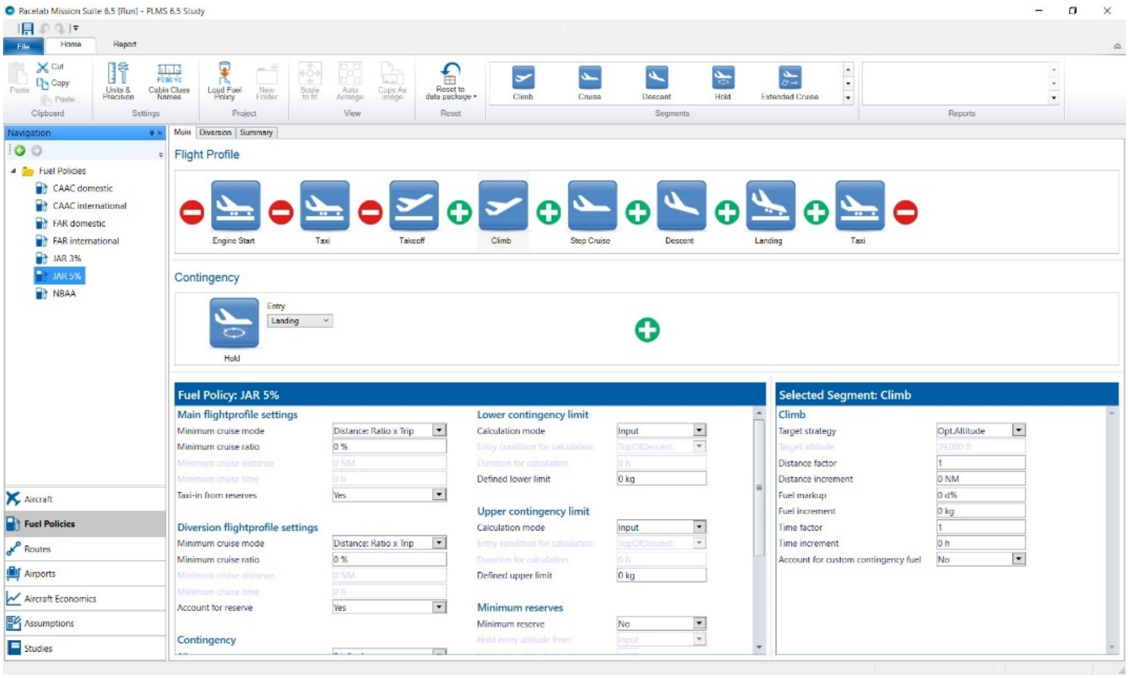

Figure 4-4: Pacelab Mission Suite - Fuel Policies Graphical Definition

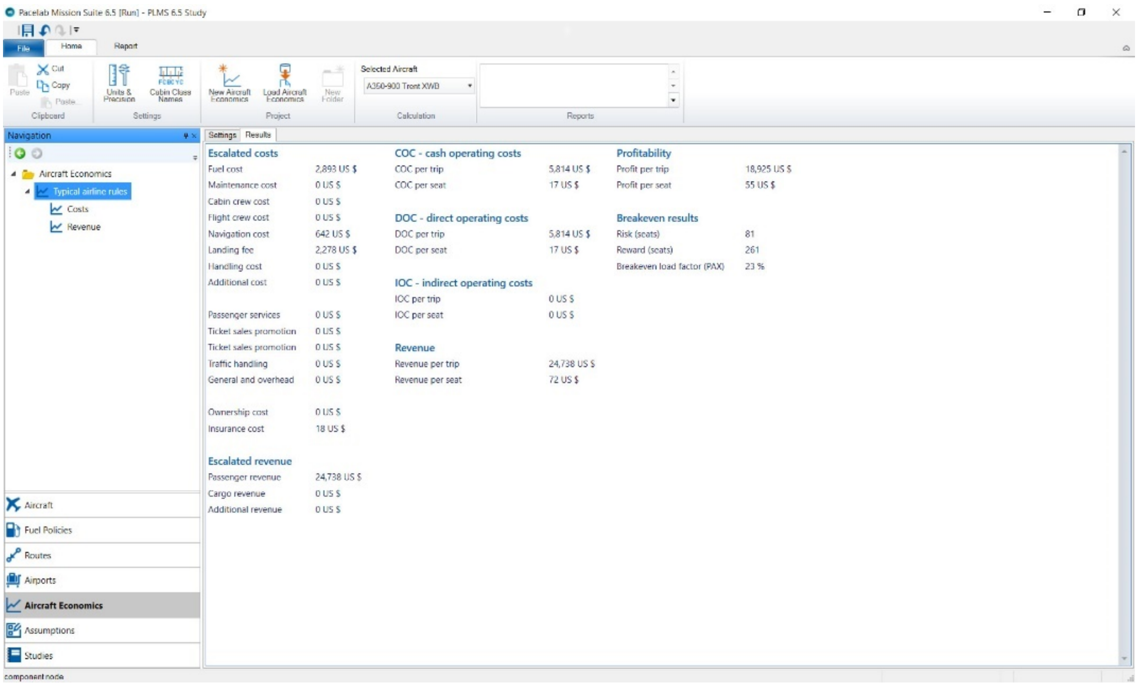

Figure 4-5: Pacelab Mission Suite - Economics Cost Analysis

The Pacelab Mission Suite allows to conduct complex trade-off investigations by performing flight performance or aircraft economics calculations for a combination of (multiple) aircraft, routes, runways, and/or aircraft economics items, subject to user-defined variations of corresponding parameter values. Reports of investigation results can be generated in Microsoft Excel or Google Earth in order to visualize them in summaries, data grids, charts and on maps.

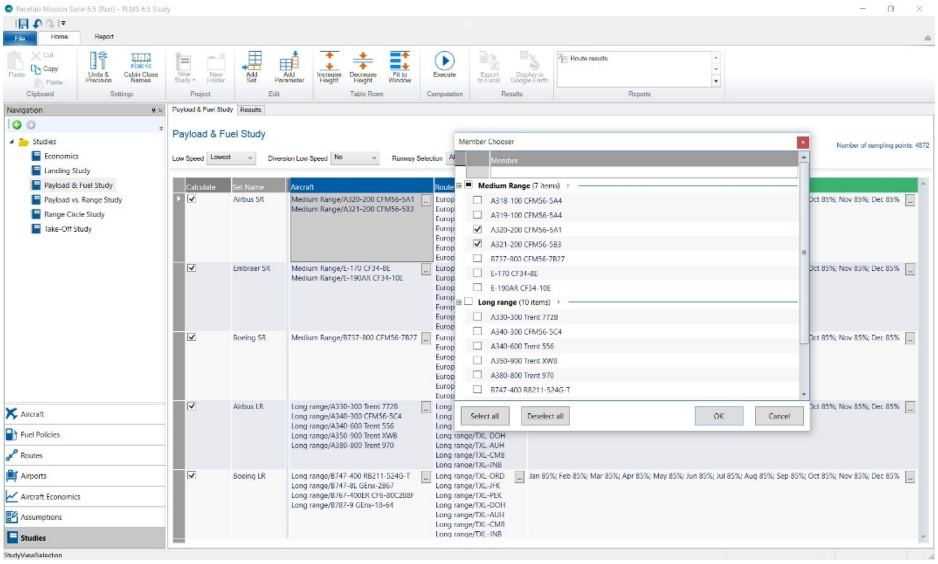

Figure 4-6: Pacelab Mission Suite - Studies Payload and Fuel

In the scope of the ICARUS project, the Pacelab Mission Suite is to be considered as an aviation data provider and aviation data and service asset consumer. Two scenarios exist that expose a reasonable linkage between the Pacelab Mission Suite and the ICARUS platform, as follows:

- Scenario 1: Pollution Data Analysis
- Scenario 2: Massive Route Network Analysis and Evaluation

Both scenarios include input data preparation, data processing and output data post-processing parts. The Pacelab Mission Suite is to perform the data processing parts as a single-user Windows application. This includes aircraft performance calculations of various kinds in order to create the aforementioned operational key metrics. The ICARUS platform is to perform the output data post-processing parts, data linking and input data preparations, where applicable. The following sections describe the two scenarios in more detail.

4.1 Demonstrator Scenario 1: Pollution Data Analysis

The scope of the demonstrator scenario comprises a set of activities aiming to support a more accurate analysis of pollution data and aircraft emissions. Typical use cases in this field involve the modelling of pollution data and the prediction of aircraft performance in relation to the environmental impact.

Adequate input data shall be compiled, with support of the ICARUS platform data exploration, curation and linking functionalities, where applicable, and processed with the Pacelab Mission Suite.

The results from the performance calculations shall then be uploaded to the ICARUS platform, post-processed with suitable ICARUS analytics and linked with other flight information data, if applicable.

Furthermore, suitable web dashboards/visualizations shall be created to allow data consumers to review aircraft fuel burn and carbon emissions for defined flight legs. The result data shall be displayed as absolute numbers per flight leg and, if feasible, on a map or in a chart view. Following the data visualization, the data consumer shall also be able to export the retrieved data as a downloadable file.

The following figure depicts the relevant systems interactions scheme on a simple level.

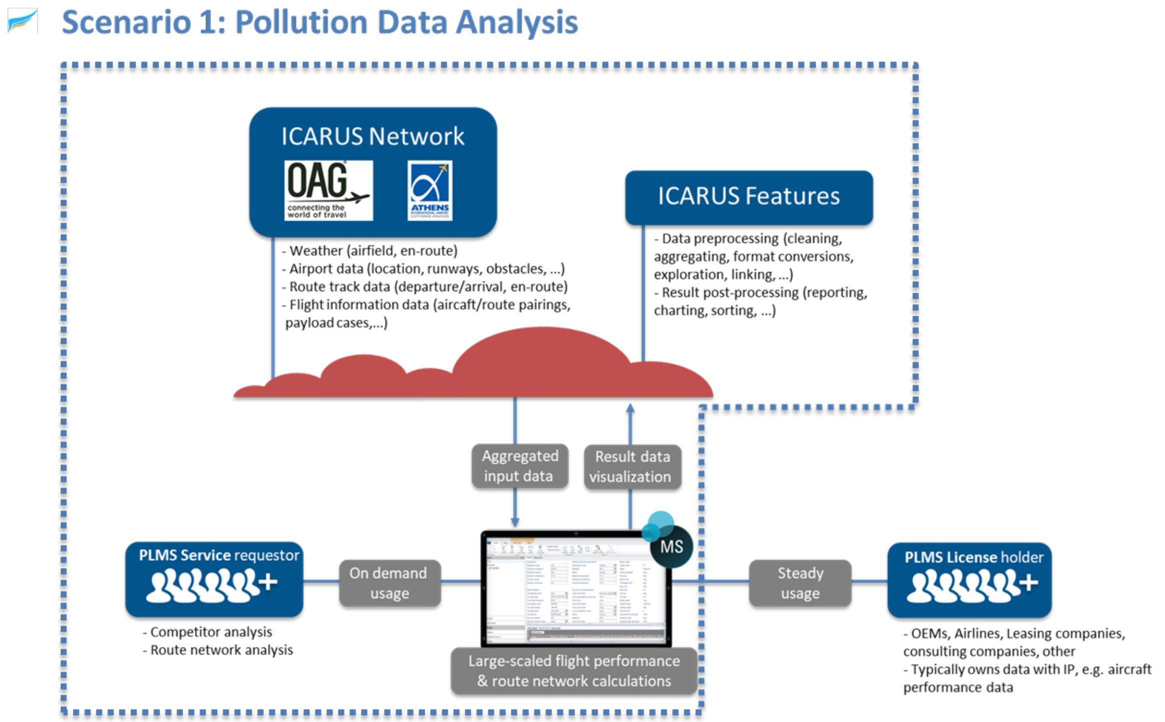

Figure 4-7: Scenario 1 systems interactions scheme

4.1.1 Current Challenges

Creating accurate aircraft performance data is a complex and costly task that requires not only the use of specialized software applications but also the involvement of subject matter experts. Moreover, the aircraft performance data is in most cases subject to confidentiality restrictions and thus requires comprehensive bilateral arrangements and non-disclosure agreements. Dealing with such restricted data is surely one of the main challenges for the envisaged ICARUS platform scenario.

In addition, the aviation sector is known to be a data-intensive industry and today, there is a lot of competition between various professional data providers making it almost impossible to access high quality data free of charge. Finding a good compromise between the give-away of data and a healthy data business is surely another challenge for the envisaged ICARUS platform scenario.

Another aspect of the envisaged scenario is the diversity of the type of relevant data, ranging from simple geographical information to linked calculation result tables. In addition, the formats of the data often vary depending on the origin and background of the data consumer and the data provider. Dealing with this diversity is surely a challenge for the envisaged universal principles for improved data analytics.

The following bullet points emphasize the main scenario challenges:

- Offering confidential data of various kinds in a secure and trustful manner
- Perceiving data availabilities and understanding the market's data needs
- Purchasing data efficiently and in a secure manner
- Linking data of various kinds and confidentiality levels
- Exploring business analytics in a state-of-the-art and efficient manner

4.1.2 Business Objectives

The objective of the scenario is to provide aviation stakeholders with simplified yet accurate aircraft performance and pollution data on the basis of actual flight routes. In particular, this scenario will allow PACE to:

- Provide more accurate pollution data by:
  - Supporting a standardized way of inputting data from various sources
  - Applying more realistic route conditions
  - Applying exact aircraft performance calculations
- Provide a more convenient emission calculation capability by:
  - Reducing the initial expenditures
  - Connecting interfering systems more efficiently
  - Supporting a wider range of data post-processing capabilities

4.1.3 Interaction with the Aviation Value Chain

The presented scenario requires interactions between aviation data providers and data and service asset consumers as presented in Table 4-1. The aviation data providers involve actors of the first tier. The aviation data and asset consumers involve actors of the first, second and third tiers. Between those groups of actors, the ICARUS platform is the single means of communication, i.e. it eliminates the need for individual actors' interactions. Regulations and obligations of the data and asset consumers must match the demands of the data asset providers and are centrally managed by the ICARUS platform.

By the execution of the demonstrator scenario, simplified yet accurate aircraft performance and pollution data is made available not only to actors of the first tier but also to actors of the second and third tiers.

Table 4-1: PACE Scenario 1 Actors' Involvement

Level	Actor Type	Interaction Details
1	Aircraft Performance Software Provider	Offer aircraft performance data, uses weather data inputs from Weather Data Provider, uses route network inputs from Route Network Data Provider, uses operational airport data from Airport Data Provider
1	Weather Data Provider	Offer statistical weather data, uses route network definitions from Aircraft Performance Software Provider
1	Route Network Data Provider	Offer historical route network data
1	Airport Data Provider	Offer operational airport data
1	Aircraft Performance Data Consumer, e.g. airports, lessors	Purchase aircraft performance and pollution data, e.g. for environmental impact analysis
3	Aircraft Performance Data Consumer, e.g. governmental and non-governmental organizations, consulting companies, private individuals	Purchase aircraft performance and pollution data, e.g. for non-governmental statistics

4.1.4 Business Processes: AS-IS and TO-BE

The present scenario aims to improve the business process of acquiring carbon emission data and the accuracy of the aircraft performance data being used for the analysis.

Table 4-2: PACE Scenario 1 Business Processes

Scenario	**Pollution Data Analysis**
Business Process	Calculate Carbon Emissions
AS-IS Situation (Before ICARUS)	**TO-BE Situation (With ICARUS)**
• Open ICAO carbon emission online calculator • Define each flight leg manually by entering departure and arrival airports • Calculate carbon emissions • View carbon emission figures in online table	• Make Pacelab Mission Suite data available in ICARUS • Upload city pair distance data to ICARUS • Link city pair distance data with Pacelab Mission Suite data in ICARUS • Optional: Link historical flight leg data with Pacelab Mission Suite data in ICARUS • Analyse carbon emissions per flight leg with ICARUS • Make ICARUS calculation results available offline in human readable format, e.g. Excel file, ASCII text file, PDF file
Critical ICARUS Features	Critical platform features derived from the methodology in D1.2. • PLATF_F_02 Uploading of data assets as files extracted by the aviation stakeholder's back-end system • PLATF_F_18 Searchability and identification of related additional data assets • PLATF_F_22 Definition of simple and advanced "information" queries

	• PLATF_F_29 Definition of an analytic task that runs an individual algorithm • PLATF_F_35 Execution of an analytics task / algorithm according to specific preferences and settings for computation resources • PLATF_F_38 Visualization of the analytics results to gain insights on the data and / or comparison how the same results are visualized in different diagrams • PLATF_F_42 Export of analytics reports as a downloadable file • PLATF_F_51 Proposition of additional data assets for the enrichment of existing data assets and / or for analysis and visualisation • PLATF_F_57 Negotiation of a data sharing agreement

4.1.5 Test Cases

The tests associated to the specific scenario are derived from the execution steps of the TO-BE situation described in section 4.1.4. The aim of the tests is to verify the operability of the scenario and to validate the targeted business objectives in the ICARUS platform.

In the specific scenario, the following test cases will be examined:

- Make Pacelab Mission Suite data available in ICARUS
- Upload city pair distance data to ICARUS
- Link city pair distance data with Pacelab Mission Suite data in ICARUS
- Optional: Link historical flight leg data with Pacelab Mission Suite data in ICARUS
- Analyse carbon emissions per flight leg with ICARUS
- Make the ICARUS calculation results available offline in human readable formats.

The associated test cases are described in more detail in the following tables.

Table 4-3: PACE Scenario 1 Test Case 1

Test Case	**Make Pacelab Mission Suite data available in ICARUS**
Actors	PACE as ICARUS user, ICARUS platform
Importance	High
Pre-conditions	• Pacelab Mission Suite calculation terminated successfully
Post-conditions	• PACE user logged in to ICARUS platform • Pacelab Mission Suite data published as confidential data of the PACE organization in the ICARUS marketplace
Workflow	1. Open the ICARUS platform with browser 2. Log-in to ICARUS platform with the user credentials 3. Select option to add aircraft performance data set 4. Browse for Pacelab Mission Suite csv file 5. Encrypt the Pacelab Mission Suite data in the On Premise Environment following the data preparation steps as provided by the Core ICARUS platform 6. Upload Pacelab Mission Suite data from the On Premise Environment to the Core ICARUS platform 7. Define data access policies, data confidentiality and data license details
Alternative Flows	4a. Select a single or multiple csv file(s)

	4b. Select a single or multiple xlsx/xls file(s)
Related ICARUS Phase	Data Collection, Asset Storage
Success Indication	Data check-in terminates with message
Failure Indication	Data check-in aborts without notification
Notes	Optionally the platform may provide compatibility with Microsoft Excel files (xlsx and xls) that do not include more than 1 worksheet. The confidentiality level may control whether the data is purchasable and the kinds of analytics that can be done with the data. The data access policies will control to whom the data is offered.

Table 4-4: PACE Scenario 1 Test Case 2

Test Case	**Upload city pair distance data to ICARUS**
Actors	PACE as ICARUS user, ICARUS platform
Importance	High
Pre-conditions	• PACE user logged in to ICARUS platform
Post-conditions	• City pair distance data stored as confidential data in the ICARUS platform
Workflow	1. Select option to upload city pair distance data set 2. Browse for city pair csv file 3. Upload city pair distance data (to be treated as confidential and available only to PACE) 4. Display city pair distance data in tabular form and in different visualizations
Alternative Flows	2a. Select a single or multiple csv file(s) 2b. Select a single or multiple xlsx/xls file(s)
Related ICARUS Phase	Data Collection, Asset Storage
Success Indication	Data upload terminates with message
Failure Indication	Data upload aborts without notification
Notes	Optionally the platform may provide compatibility with Microsoft Excel files (xlsx and xls) that do not include more than 1 worksheet.

Table 4-5: PACE Scenario 1 Test Case 3

Test Case	**Link city pair distance data with Pacelab Mission Suite data in ICARUS**
Actors	PACE as ICARUS user, ICARUS platform
Importance	High
Pre-conditions	• PACE user logged in to ICARUS platform • Pacelab Mission Suite data available only to PACE in the ICARUS data marketplace • City pair distance data available as confidential data in the ICARUS platform
Post-conditions	• City distance data linked with Pacelab Mission Suite data

Workflow	1. Browse the PSCE-owned data in the ICARUS marketplace in order to find the Pacelab Mission Suite data 2. Select one or multiple Pacelab Mission Suite data set(s) 3. Establish link between city pair distance data and Pacelab Mission Suite data set(s) in the ICARUS workspace a. Use city pair distance data as basis b. Per city pair connection lookup distance-based performance data in Pacelab Mission Suite data set(s) c. Enrich city pair distance data with fuel and carbon emissions data
Alternative Flows	3a Assist user with data linking
Related ICARUS Phase	Data Collection, Data Enrichment, Asset Storage, Asset Sharing
Success Indication	Data set(s) linking terminates with message
Failure Indication	Data set(s) linking aborts without notification. Data set(s) purchase fails with message.
Notes	The data linking shall enable the execution of interpolation and lookup algorithms.

Table 4-6: PACE Scenario 1 Test Case 4

Test Case	**Link city pair distance data with historical flight leg data in ICARUS**
Actors	PACE as ICARUS user, ICARUS platform, OAG
Importance	Medium
Pre-conditions	• PACE user logged in to the ICARUS platform • Pacelab Mission Suite data available as confidential data in the ICARUS platform • OAG flight schedule data available in the ICARUS data marketplace
Post-conditions	• OAG flight schedule data linked with Pacelab Mission Suite data in the ICARUS platform
Workflow	1. Search the ICARUS marketplace for flight schedule data 2. Explore the available dataset(s) 3. Select one or multiple other data set(s) 4. Purchase OAG flight schedule data 5. Establish link between city pair distance data, OAG flight schedule data and Pacelab Mission Suite data in the ICARUS workspace a. Use city pair distance data as basis b. Per historical flight average wind and temperature in OAG flight schedule data c. Per city pair connection lookup average wind and temperature in OAG flight schedule data d. Per city pair connection lookup distance-based performance data in Pacelab Mission Suite data set(s) respecting average wind and temperature e. Enrich city pair distance data with fuel and carbon emissions data
Alternative Flows	4a Assist user with data linking
Related ICARUS Phase	Data Collection, Data Enrichment, Asset Storage, Asset Sharing
Success Indication	Data set(s) sharing and linking terminates with message

Failure Indication	Data set(s) linking aborts without notification. Data set(s) sharing fails with notification.
Notes	The data linking shall enable the execution of interpolation and lookup algorithms. In particular, data linking is required for the flight leg distance, historical airport temperature, en-route temperature and wind and load factor data.

Table 4-7: PACE Scenario 1 Test Case 5

Test Case	**Analyse carbon emissions per flight leg with ICARUS**
Actors	PACE as ICARUS user, ICARUS platform
Importance	High
Pre-conditions	• PACE user logged in to the ICARUS platform • PACE user has his/her ICARUS secure and private workspace at his/her disposal • Pacelab Mission Suite data available as confidential data in the ICARUS platform and the secure and private workspace of PACE • City pair distance data or OAG flight schedule data available in the ICARUS platform and the secure and private workspace of PACE • ICARUS analytics algorithms exist in the ICARUS platform and are accessible through the secure and private workspace of PACE
Post-conditions	• Carbon emissions data displayed to user in his/her ICARUS workspace
Workflow	1. Select relevant city pairs from city pair distance data for analysis 2. Select airport temperature level from high, medium, low 3. Select en-route temperature level from high, medium, low 4. Select en-route wind condition from strong, weak or null head-/tail-wind 5. Select load-factor scenario from full or half-full 6. Retrieve carbon emissions via interpolation and linkage between city pair and Pacelab Mission Suite data set(s) 7. Display carbon emission data for selected city pairs 8. Provide the carbon emission results as an ICARUS application that additional users may buy
Alternative Flows	1b Select relevant city pairs from OAG flight schedule data for analysis 6b Retrieve carbon emissions via interpolation and linkage between OAG flight schedule and Pacelab Mission Suite data set(s)
Related ICARUS Phase	Data Analytics, Added Value Services
Success Indication	Calculation terminates with message
Failure Indication	Calculation aborts without notification
Notes	Optionally the same task may be performed with OAG flight schedule data instead of city pair distance data. Hereby an automatism logic is assumed that covers the steps 2-5 of the initial workflow.

Table 4-8: PACE Scenario 1 Test Case 6

Test Case	**Make ICARUS calculation results available offline in human readable format**
Actors	PACE as ICARUS user, ICARUS platform

Importance	High
Pre-conditions	• PACE user logged in to the ICARUS platform • Carbon emission data available as confidential derivative data in the ICARUS platform
Post-conditions	• Carbon emission data saved on local storage
Workflow	1. Select option to download carbon emission data, if permitted from its license 2. Select target file type, e.g. csv format 3. Encrypt carbon emission data in the ICARUS secure workspace 4. Download encrypt carbon emission data locally 5. Decrypt and access carbon emission data
Alternative Flows	1b Consider the carbon emission data completely or partly
Related ICARUS Phase	Data Analytics, Added Value Services
Success Indication	Data set(s) download terminates with message
Failure Indication	Data set(s) download aborts without notification
Notes	The list of file types is a suggestion and is not comprehensive.

4.1.6 Data Availability and Needs

Executing the business processes and tests that are specific for the scenario "Pollution Data Analysis" requires various kinds of data some of which are already available whereas others are needed. The data availability and needs are summarized in the following tables. Data with a high criticality can be considered mandatory as they are vital for the success of the scenario tests and business processes. Data with a medium criticality can be considered optional for the scenario success but still valuable for the overall scenario outcome. Data with a low criticality can be considered irrelevant for the scenario success.

Table 4-9: PACE Scenario 1 Data Available Overview

ID	Data Asset Title	Data Provider	Criticality
PACE_02	Notional[2] aircraft performance data	PACE	High
PACE_04	Notional weather data	PACE	High
PACE_08	Notional payload data	PACE	High

Table 4-10: PACE Scenario 1 Data Needed Overview

ID	Data Asset Title	Data Provider	Criticality	Status
PACE_DR_01	Actual national and international airport data library	Airport (AIA)	Medium	Under investigation

[2] Official wording for aircraft performance data that PACE created using in-house applications.

ID	Data Asset Title	Data Provider	Criticality	Status
PACE_DR_02	Historical airport weather data at ground level	OAG	Medium	To be available in ICARUS platform
PACE_DR_03	Historical en-route weather data	UBIMET	Medium	Under investigation
PACE_DR_04	Historical flights departure paths (above FL100)	OAG	Medium	To be available in ICARUS platform
PACE_DR_05	Historical flights arrival paths (above FL100)	OAG	Medium	To be available in ICARUS platform
PACE_DR_06	Historical airport taxi in/out times	OAG, Airport (AIA)	Medium	To be available in ICARUS platform
PACE_DR_07	Historical operational costs	To be investigated	Medium	Under investigation
PACE_DR_08	Historical flight schedule data	OAG	Medium	To be available in ICARUS platform

More detailed information about the data available and needed is provided in the ICARUS Deliverable D1.1 “Domain Landscape Review and Data Value Chain Definition” and shall be updated in the forthcoming Deliverable D1.3 “Updated ICARUS Methodology and MVP”.

4.2 Demonstrator Scenario 2: Massive Route Network Analysis and Evaluation

The scope of the demonstrator scenario “Massive Route Network Analysis and Evaluation” comprises a set of activities aiming to analyse pollution data on a larger scale, that of a massive route network. Typical use case examples in this field involve the statistical evaluation of weather data, the modelling of aircraft payload capacity scenarios and the prediction of aircraft performance in relation to the underlying route network.

Adequate input data shall be compiled, uploaded to the ICARUS platform and pre-processed with ICARUS data platform. Then, the data shall be downloaded and processed with the Pacelab Mission Suite. The results from the performance calculations shall be uploaded to the ICARUS platform, post-processed with suitable ICARUS analytics, visualized in a state-of-the-art manner and shared either inside or outside the company.

The following figure depicts the relevant systems interactions scheme on a simple level.

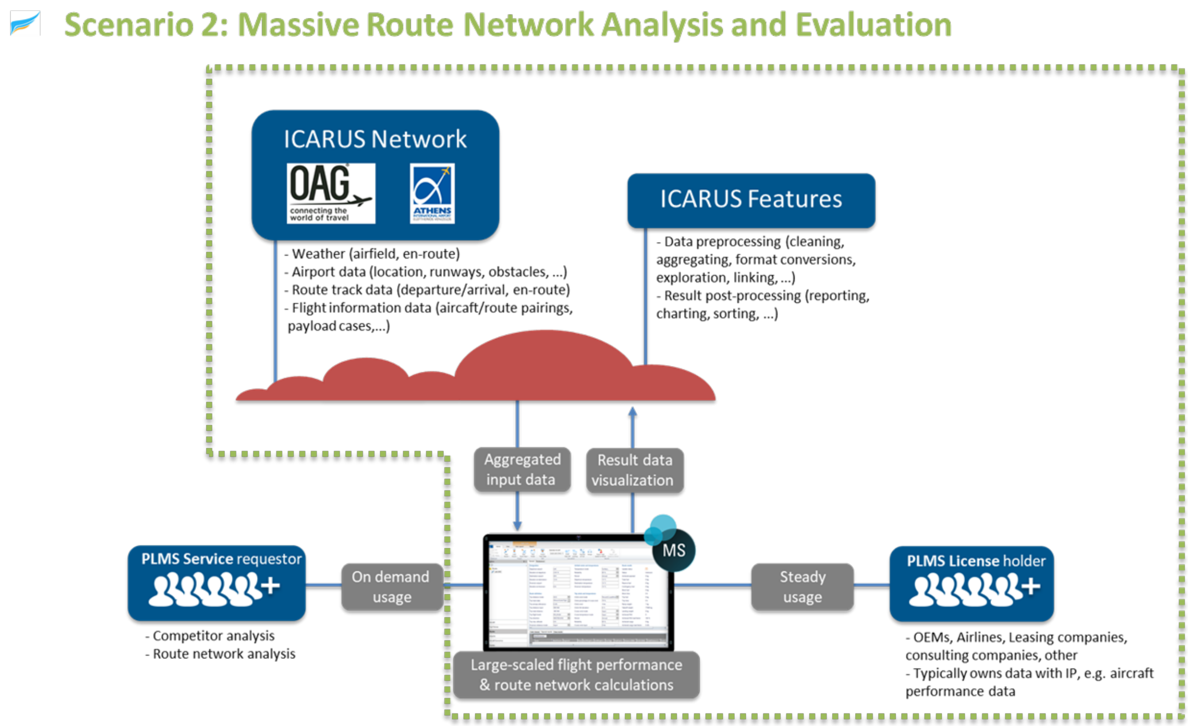

Figure 4-8: PACE Scenario 2 systems interactions scheme

4.2.1 Current Challenges

As described in section 4.1.1 for the PACE demonstrator scenario 1, creating accurate aircraft performance data is a complex and costly activity that comes across a set of challenges, i.e. the necessary use of dedicated software, the involvement of domain experts, the agreement of the involved parties to share aircraft performance data through bilateral agreements, the cost of acquiring high quality data, and the data diversity and variety.

The following bullet points emphasize the main challenges for the specific scenario:

- Handling confidential data in a secure workspace environment
- Purchasing confidential data of various kinds in a secure and trustful manner
- Linking data of various kinds and confidentiality levels
- Dealing with large data set(s) (more than 1 million rows)
- Exploring high performance computing resources at favorable conditions

4.2.2 Business Objectives

The objective of the scenario is to provide the aviation stakeholders with advanced data exploration, evaluation and visualization capabilities on the basis of large route network data.

- Provide better case study automation by
  - Supporting a standardized way of inputting and exploring data from various sources
  - Using more efficient data handling capabilities
  - Reducing the need for manual data processing
- Provide better big data analytics by
  - Supporting wider data variations
  - Offering better data linking capabilities
  - Applying advanced data visualizations

4.2.3 Interaction with the Aviation Value Chain

The presented scenario requires interactions between aviation data providers and data and service asset consumers. All actors are assumed to originate from the first tier, however, differ in terms of their needs and objectives. Between all actors, the ICARUS platform is the single mean of communication, i.e. it eliminates the need for individual actor interactions. Regulations and obligations of the data and asset consumers must match the demands of the data and asset providers and are centrally managed by the ICARUS platform.

By the execution of the demonstrator scenario, enhanced data analytics are made available to actors of the first tier.

Table 4-11: PACE Scenario 2 Actors' Involvement

Level	Actor Type	Interaction Details
1	Aircraft Performance Data Provider	Offer aircraft performance data, uses weather data inputs from Weather Data Provider, uses route network inputs from Route Network Data Provider, uses operational airport data from Airport Data Provider
1	Weather Data Provider	Offer statistical weather data, uses route network definitions from Aircraft Performance Software Provider
1	Route Network Data Provider	Offer historical route network data
1	Airport Data Provider	Offer operational airport data
1	Aircraft Performance Data Consumer, e.g. airlines, lessors, OEMs	Purchase aircraft performance and economics data, e.g. for airlines fleet economic analysis or OEM competitor analysis.

4.2.4 Business Processes: AS-IS and TO-BE

The scenario aims to improve the business processes of the Pacelab Mission Suite route network analysis in terms of input data conditioning and output data analytics and visualizations.

Table 4-12: PACE Scenario 2 Business Processes

Scenario	Massive Route Network Analysis and Evaluation
Business Process	Consolidate Route Network Analysis Inputs

AS-IS Situation (Before ICARUS)	TO-BE Situation (With ICARUS)
• Purchase historical airport weather data or recreate these eventualities with Pacelab Mission Suite assumption tables • Purchase historical en-route temperature and wind data or recreate these eventualities with Pacelab Mission Suite assumption tables • Purchase historical flight information data or recreate these eventualities with Pacelab Mission Suite assumption tables	• Browse the ICARUS platform for historical airport weather data, historical en-route temperature and wind data and historical flight information data • Collect historical airport weather data, historical en-route temperature and wind data and historical flight information data and download as importable files • Import historical airport weather, en-route temperature and wind and flight information data as Pacelab Mission Suite assumption table

Business Process	Customize Route Network Analysis Outputs

AS-IS Situation (Before ICARUS)	TO-BE Situation (With ICARUS)
• Create Microsoft Excel macros for intelligent data analytics and visualization of raw calculation outputs • Use Tableau for analysis and statistics of raw calculation outputs • Use Google Earth or Pacelab Mission Suite in-tool map to display maximum range values	• Upload raw calculation outputs to the ICARUS platform • Establish linkages between different data sets • Browse the ICARUS platform for advanced data analytics and / or create specific analytics workflows • Apply advanced data analytics on data sets • Use charting features to better exploit the benefits of large scaled route network studies

Critical ICARUS Features	Critical platform features derived from the methodology in D1.2. • PLATF_F_01 Retrieval of data directly from an aviation stakeholder's back-end system • PLATF_F_02 Uploading of data assets as files extracted by the aviation stakeholder's back-end system • PLATF_F_18 Searchability and identification of related additional data assets • PLATF_F_22 Definition of simple and advanced "information" queries • PLATF_F_27 Transformation of a data asset to other supported data formats and export • PLATF_F_28 Navigation to preconfigured analytics • PLATF_F_29 Definition of an analytic task that runs an individual algorithm • PLATF_F_30 Definition of a workflow of analytic tasks that combine algorithms • PLATF_F_35 Execution of an analytics task / algorithm according to specific preferences and settings for computation resources • PLATF_F_38 Visualization of the analytics results to gain insights on the data and / or comparison how the same results are visualized in different diagrams • PLATF_F_39 Definition of customized dashboards by selecting which visualizations should appear • PLATF_F_42 Export of analytics reports as a downloadable file • PLATF_F_51 Proposition of additional data assets for the enrichment of existing data assets and / or for analysis and visualisation • PLATF_F_57 Negotiation of a data sharing agreement

4.2.5 Test Cases

The tests associated to the specific scenario are derived from the execution steps of the TO BE situation. The aim of the tests is to verify the operability of the scenario and to validate the targeted business objectives.

In the specific scenario, the tests to be performed on the ICARUS platform comprise 9 cases:

- Browse the ICARUS platform for data sets
- Establish linkages between different ICARUS data sets
- Download data sets from the ICARUS platform
- Securely upload the Pacelab Mission Suite data to the ICARUS platform
- Link the Pacelab Mission Suite data to other data available in the ICARUS platform
- Browse the ICARUS platform for analytics algorithms
- Define and apply the ICARUS analytics algorithms in secure and private workspaces, fully controlled by PACE
- Visualize the analytics results in appropriate charts/dashboards

The associated test cases are described in more detail in the following tables.

Table 4-13: PACE Scenario 2 Test Case 1

Test Case	**Browse the ICARUS platform for data sets**
Actors	PACE as ICARUS user, ICARUS platform
Importance	Medium
Pre-conditions	• Data sets available in the ICARUS market place
Post-conditions	• PACE user logged in to the ICARUS platform • The secure and private workspace of the PACE user is available in ICARUS • Data sets purchased and available in his/her secure and private workspace in ICARUS
Workflow	1. Log-in to ICARUS platform with user credentials 2. Open the ICARUS marketplace 3. Define data query by data type, format, keywords 4. Submit data query 5. Navigate to and review data query results 6. Access public data set(s) and private data set(s) samples 7. Purchase the related private data set(s) 8. Display data set(s) in the PACE user space
Alternative Flows	6b Select a single or multiple data set(s) 7b Select a single or multiple data set(s)
Related ICARUS Phase	Data Exploration, Data Asset Sharing
Success Indication	Data query terminates with message
Failure Indication	Data query aborts without notification
Notes	This test case is optional in terms of the critical scenario execution since the associated data criticality level is medium.

Table 4-14: PACE Scenario 2 Test Case 2

Test Case	Establish linkages between different ICARUS data sets
Actors	PACE as ICARUS user, ICARUS platform
Importance	Medium
Pre-conditions	• PACE user logged in to the ICARUS platform • The secure and private workspace of the PACE user is available in ICARUS • Data sets available in the user's secure and private workspace in ICARUS
Post-conditions	• Different data sets linked in the user's secure and private workspace in ICARUS
Workflow	1. Select dataset(s) to be linked 2. Get recommendations for datasets that can be potentially linked 3. Establish links between different data sets in the user's secure and private workspace in ICARUS by single keys, e.g. column name, or by key pairs
Alternative Flows	1b Select one or multiple data set(s)
Related ICARUS Phase	Data Collection, Data Enrichment, Asset Storage, Recommendations
Success Indication	Data set(s) linking terminates with message
Failure Indication	Data set(s) linking aborts without notification
Notes	This test case is optional in terms of the critical scenario execution since the associated data criticality level is medium.

Table 4-15: PACE Scenario 2 Test Case 3

Test Case	Download data sets from the ICARUS platform
Actors	PACE as ICARUS user, ICARUS platform
Importance	Medium
Pre-conditions	• PACE user logged in to the ICARUS platform • The secure and private workspace of the PACE user is available in ICARUS • Datasets purchased and available in the user's secure and private workspace in ICARUS
Post-conditions	• Datasets saved on local storage
Workflow	1. Select option to download data set(s) 2. Browse for target folder 3. Select target file type 4. Download encrypted data set(s) on the On Premise Environment 5. Decrypt data set(s) on the On Premise Environment
Alternative Flows	1b Consider the data set completely or partly
Related ICARUS Phase	Asset Exploration, Asset Sharing
Success Indication	Data set(s) download terminates with message
Failure Indication	Data set(s) download aborts without notification

Notes	This test case is optional in terms of the critical scenario execution since the associated data criticality level is medium.

Table 4-16: PACE Scenario 2 Test Case 4

Test Case	**Securely upload the Pacelab Mission Suite data to the ICARUS platform**
Actors	PACE as ICARUS user, ICARUS platform
Importance	High
Pre-conditions	• Pacelab Mission Suite calculation terminated successfully
Post-conditions	• PACE user logged in to the ICARUS platform • The secure and private workspace of the PACE user is available in ICARUS • Pacelab Mission Suite data tagged as confidential and stored in ICARUS private and secure workspace
Workflow	1. Open the ICARUS platform with a browser 2. Access the ICARUS private and secure workspace 3. Select option to add aircraft performance data set 4. Browse for Pacelab Mission Suite csv file 5. Encrypt the Pacelab Mission Suite data 6. Upload the encrypted Pacelab Mission Suite data to the ICARUS platform 7. Indicate the access policies of the Pacelab Mission Suite data (e.g. confidential, not to be accessed by any stakeholder apart from PACE) 8. Display information for the uploaded data set(s)
Alternative Flows	4a. Select a single or multiple csv file(s) 4b. Select a single or multiple xlsx/xls file(s)
Related ICARUS Phase	Data Collection, Asset Storage
Success Indication	Data upload terminates with message
Failure Indication	Data upload aborts without notification
Notes	This test case is mandatory in terms of the critical scenario execution. The Pacelab Mission Suite data must not be published in the marketplace but must remain in the secure user workspace/sandbox environment only.

Table 4-17: PACE Scenario 2 Test Case 5

Test Case	**Link the Pacelab Mission Suite data to other data available in the ICARUS platform**
Actors	PACE as ICARUS user, ICARUS platform, OAG
Importance	Medium
Pre-conditions	• PACE user logged in to the ICARUS platform • The secure and private workspace of the PACE user is available in ICARUS • Pacelab Mission Suite data available in the PACE secure and private workspace in ICARUS • Related data available in ICARUS marketplace
Post-conditions	• Pacelab Mission Suite data linked with related data in the ICARUS secure and private workspace of PACE

Workflow	1. Browse the ICARUS market place for related data set(s) 2. Select one or multiple related data set(s) 3. Purchase related data (if not public) 4. Establish link between Pacelab Mission Suite data set(s) and related data in the ICARUS secure and private workspace of PACE
Alternative Flows	4b Assist user with data linking
Related ICARUS Phase	Data Exploration, Data Enrichment, Asset Sharing
Success Indication	Data linking terminates with message
Failure Indication	Data linking aborts without notification
Notes	This test case is optional in terms of the critical scenario execution since the associated data criticality level is medium.

Table 4-18: PACE Scenario 2 Test Case 6

Test Case	**Browse the ICARUS platform for analytics algorithms**
Actors	PACE as ICARUS user, ICARUS platform
Importance	High
Pre-conditions	• PACE user logged in to the ICARUS platform • The secure and private workspace of the PACE user is available in ICARUS • Pacelab Mission Suite data available in the PACE secure and private workspace in ICARUS
Post-conditions	• Available analytics algorithms are displayed
Workflow	1. Open the ICARUS platform 2. Search the ICARUS marketplace for available applications that apply analytics algorithms and are related to the Pacelab Mission Suite data 3. Review and filter results to find the most appropriate application 4. Select the application of interest 5. Purchase the application if it is not free
Alternative Flows	1b Access the Analytics and Visualisation Workbench through the ICARUS platform 2b Search available algorithms by type, used data or keywords in the workbench 3b Review related algorithms
Related ICARUS Phase	Data Analytics, Added Value Services
Success Indication	Browsing terminates with message
Failure Indication	Browsing terminates without notification
Notes	This test case is mandatory in terms of the critical scenario execution. The Pacelab Mission Suite data must not be published in the market place and be accessible by other users, but must remain in the secure user workspace/sandbox environment only.

Table 4-19: PACE Scenario 2 Test Case 7

Test Case	**Define and apply the ICARUS analytics algorithms in secure and private workspaces, fully controlled by PACE**

Actors	PACE as ICARUS user, ICARUS platform
Importance	Mandatory
Pre-conditions	• PACE user logged in to the ICARUS platform • The secure and private workspace of the PACE user is available in ICARUS • Pacelab Mission Suite data available in the PACE secure and private workspace in ICARUS • Analytics algorithm(s) available in ICARUS
Post-conditions	• Analytics results available in the PACE secure and private workspace in ICARUS
Workflow	1. Select analytics algorithms in the Analytics and Visualisation Workbench 2. Select Pacelab Mission Suite data set(s) and any other related dataset(s) 3. Design analytics workflow 4. Define options and settings of analytics algorithm, if required 5. Execute the analytics workflow in the PACE secure and private workspace in ICARUS 6. Review analytics algorithm results from the PACE secure and private workspace in ICARUS
Alternative Flows	-
Related ICARUS Phase	Data Analytics, Added Value Services
Success Indication	Applying analytics algorithm(s) terminates with message
Failure Indication	Applying analytics algorithm(s) aborts without notification
Notes	This test case is mandatory in terms of the critical scenario execution. The Pacelab Mission Suite data must not be published in the market place and be accessible by other users, but must remain in the secure user workspace/sandbox environment only.

Table 4-20: PACE Scenario 2 Test Case 8

Test Case	**Visualize the analytics results in appropriate charts/dashboards**
Actors	PACE as ICARUS user, ICARUS platform
Importance	Mandatory
Pre-conditions	• PACE user logged in to the ICARUS platform • The secure and private workspace of the PACE user is available in ICARUS • Pacelab Mission Suite data available as confidential data in ICARUS • Charting visualization(s) available in ICARUS • Draft analytics workflow already defined
Post-conditions	• Charting visualization available in ICARUS platform
Workflow	1. Search for available visualizations in the Analytics and Visualisation Workbench 2. Select the related analytics workflow 3. Define options and settings of charts/dashboards, whenever required 4. Execute analytics workflow in the PACE secure and private workspace in ICARUS 5. Review the visualizations displaying the results
Alternative Flows	-
Related ICARUS Phase	Data Analytics, Added Value Services

Success Indication	Applying visualization scheme(s) terminates with message
Failure Indication	Applying visualization scheme(s) aborts without notification
Notes	This test case is mandatory in terms of the critical scenario execution. The Pacelab Mission Suite data must not be published in the market place and be accessible by other users, but must remain in the secure user workspace/sandbox environment only.

4.2.6 Data Availability and Needs

Executing the scenario business processes and tests requires various data, some of which are already available whereas others are needed. The data availability and needs are summarized in the following tables. Data with a high criticality can be considered mandatory as they are considered as vital for the success of the scenario tests and business processes. Data with a medium criticality can be considered as optional for the scenario success but still valuable for the overall scenario outcome. Data with a low criticality can be considered irrelevant for the scenario success.

Table 4-21: PACE Scenario 2 Data Available Overview

ID	Data Asset Title	Data Provider	Criticality
PACE_02	Notional aircraft performance data	PACE	High
PACE_05	Notional en-route weather data	PACE	High
PACE_06	Notional airport taxi in/out times	PACE	Medium
PACE_07	Notional operational costs	PACE	Medium

Table 4-22: PACE Scenario 2 Data Needed Overview

ID	Data Asset Title	Data Provider	Criticality	Status
PACE_DR_01	Actual national and international airport data library	Airport (AIA)	Medium	Under investigation
PACE_DR_02	Historical airport weather data at ground level	OAG	Medium	To be available in ICARUS platform
PACE_DR_04	Historical flights departure paths (above FL100)	OAG	Medium	To be available in ICARUS platform
PACE_DR_05	Historical flights arrival paths (above FL100)	OAG	Medium	To be available in ICARUS platform

More detailed information about the data available and needed is provided in the ICARUS Deliverable D1.1 "Domain Landscape Review and Data Value Chain Definition" and shall be updated in the forthcoming Deliverable D1.3 "Updated ICARUS Methodology and MVP WP1".

4.3 Considerations, Constraints and Preconditions

A key consideration for the PACE demonstrator scenarios is that they practically constitute a simplification in terms of the anticipated business users, i.e. PACE will execute the scenarios on behalf of the relevant aviation stakeholders. In the future, such stakeholders are expected to directly use the PACE offering through the ICARUS platform as it is intended to be provided as a private application.

In parallel, a set of preconditions can be identified: (a) The ICARUS platform is up and running; (b) An identified user account exists on the ICARUS platform; (c) The OAG data is available in the ICARUS marketplace. Certain constraints are expectedly imposed due to the extra security layers as the on-premise environment at the PACE premises (e.g. for data encryption) needs to be always up and running.

4.4 Business Impact and Expected Benefits

The creation of the ICARUS platform as a centralized and secure environment for providing and consuming aviation data constitutes the main business impact and offers great opportunities along the whole aviation data value chain. The list of expected benefits includes but is not limited to:

- A higher standardization of data business contracts and transactions
- A wider customer base for business data analytics and purchasing
- A higher reputation in the aviation industry
- A robust basis for future business developments
- A door opener to new technologies and practices

For PACE, the creation of the ICARUS platform offers the potential for growing PACE's service and license selling business mainly through the mass data exploration, linking, analysis and visualization capabilities. Among others, the expected benefits include:

- A simplification in the data purchasing and acquisition process
- A unification in the landscape of data provision and data formats
- A reduction of operational costs for maintaining data format compatibilities
- A greater variety of input data enrichments and linking capabilities
- A wider range of output data analysis and visualization capabilities
- A higher customer satisfaction along the entire value-added chain

Moreover, the ICARUS platform could be of great benefit by providing access to comprehensive and more realistic data related to route specific in air performance and airport specific ground performance. Using accurate flight track data, including lateral waypoints and the vertical flight profile, will allow better to better predict fuel consumption, which today mostly relies on great circle distances. PACE envisages to offer the results to:

- Public authorities as an instrument to calculate and check CO2 and other emissions as a basis for improved trading with certificates
- Municipalities to allow better planning of approach paths and selection of the most suitable local airport under consideration of local pollution constraints
- Airlines to enhance their flight planning by complying with regulations and achieving fuel savings and safety enhancements

At this early stage of the project, no commercial estimation of potential benefits is possible. But certainly, a better prediction of the ecological impact will lead to more efficient use of resources, which in turn will be a means to reduce cost and pollution. Finally, this will allow to actively and positively influence air traffic in the interest of all stakeholders.

Table 4-23: PACE Key Performance Indicators

Scenario	KPI	Calculation Method	AS-IS Value	TO-BE Value	Verification Means
1	Increased accuracy of pollution data	[[Accuracy of pollution data created with the help of ICARUS] – [Current pollution data accuracy]] / [Current pollution data accuracy]	-	10%	Comparisons of actual data already available from PACE with the ICARUS calculations for simulated flights
1	Improved visibility of carbon emissions	[Granularity of pollution data created with the help of ICARUS] vs [Current pollution data granularity]	Per route	Per flight	Comparisons of actual data already available from PACE with the ICARUS calculations for simulated flights
1	Expected increase in share of service business	[[Forecasted share of service business with the ICARUS add-ons] – [Current service turnover]] / [Current service turnover]	-	10%	Financial projections, interviews, questionnaires
2	Decreased time to perform mass data analysis	[[Time to perform mass data analysis based on current business practices] - [Time to perform mass data analysis with ICARUS]] / [Time to perform mass data analysis based on current business practices]	-	30%	Comparisons of actual data already available from PACE with the ICARUS calculations for simulated flights
2	Increase in the customer satisfaction for the Pacelab Mission Suite	[[Customer satisfaction upon embedding results from ICARUS] – [Current customer satisfaction for the Pacelab Mission Suite]] / [Current customer satisfaction for the Pacelab Mission Suite]	-	10%	Interviews, questionnaires

Scenario	KPI	Calculation Method	AS-IS Value	TO-BE Value	Verification Means
2	Expected increase in the Pacelab Mission Suite upselling	[[Forecasted licenses turnover with the ICARUS add-ons] – [Current licenses turnover]] / [Current licenses turnover]	-	20%	Financial projections of selling additional licenses to existing user base or to new customers

4.5 Demonstrator Execution Plan

The demonstrator execution plan foresees the subsequent execution of the two demonstrator scenarios, whereby scenario 1 is planned to be executed before scenario 2. Thereof, some tasks require the close collaboration between the platform development and the demonstrator, whereas others are foreseen to be handled inside the demonstrator premises.

In the early PACE demonstrator release (on M24), the following activities are expected:

- I.1 Scenario 1 concept evaluation and specification that includes: Data sources collection (I.1.1), Algorithm definition (I.1.2), Demonstrator plugin development (I.1.3).
- I.2 Scenario 1 prototyping & realization, focusing on: Data experimentation and analysis (I.2.1), Algorithm experimentation (I.2.2), Demonstrator plugin development (I.2.3).
- I.3 Scenario 2 concept evaluation and specification, including Algorithm & visualization definition (I.3.1) and Demonstrator plugin development (I.3.2).
- I.4 Scenario 2 prototyping & realization, that concerns: Visualization experimentation (I.4.1), Demonstrator plugin development (I.4.2).
- I.5 Implementation & application, that consists of: Scenario 1 implementation & application (I.5.1), Scenario 2 implementation & application (I.5.2), and Demonstrator plugin development (I.5.3).

In the intermediate PACE demonstrator release (expected on M30), the verification and validation activities (I.6) will be intense which shall lead to the finalization of scenario 1 (I.7) and its stabilization and industrialization (I.8) in the ICARUS platform.

Finally, the advanced demonstrator release (expected on M36) features the following activities:

- I.9 Scenario 2 Finalization in the ICARUS platform
- I.10 Scenario 2 Stabilization & Industrialization
- I.11 Lessons Learnt and Business Case Generalization

Table 4-24: Demonstration Activities for PACE

Demonstration Activities	M15	M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30	M31	M32	M33	M34	M35	M36
I.1																						
I.2																						
I.3																						
I.4																						
I.5																						
I.6																						
I.7																						
I.8																						
I.9																						
I.10																						
I.11																						

5 Demonstrator III: ISI

5.1 Business Context

This demonstrator's scope is set within the context of research and support of policy making, and in particular within the field of computational epidemiology. At the ISI Foundation, mathematical models are designed and used together with computational thinking to study the global spreading of epidemics in environments characterized by many degrees of complexity. The modelling tools aim at better understanding various phenomena related to the spread of infectious diseases, to analyse and forecast the evolution of specific epidemic outbreaks to assist policy making in case of public health emergencies.

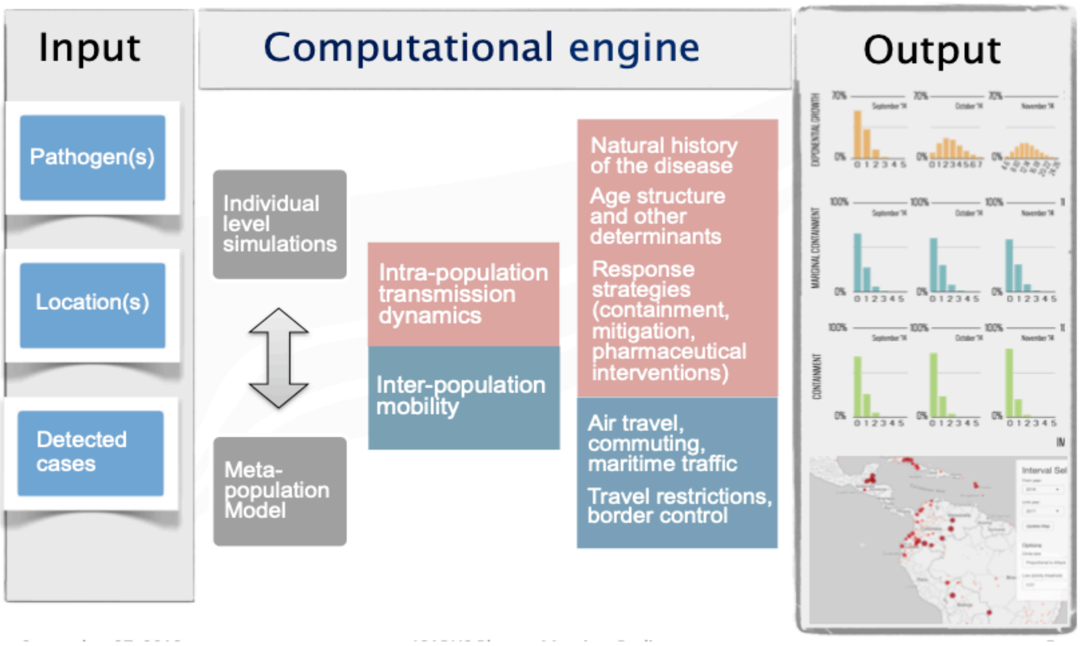

Figure 5-1: ISI computational epidemiology model

The ISI research activity has led to the development of data-driven stochastic infectious-disease models to support a wide range of epidemiological and public-health studies. The ISI simulation models run on high-performance computers to perform *in-silico* experiments that would not be feasible in real systems, leading to a better understanding of non-typical behaviours and tipping points of epidemic phenomena, and providing tools to help manage public health crisis due to transmissible infectious diseases.

The Global Epidemic and Mobility Model (GLEAM) is a meta-population model that uses a data-driven approach based on real-world data on populations and human mobility; airline traffic data is a key component for the modelling of human mobility and the simulation of the global spread of an infectious disease and their effect on the population and the economy.

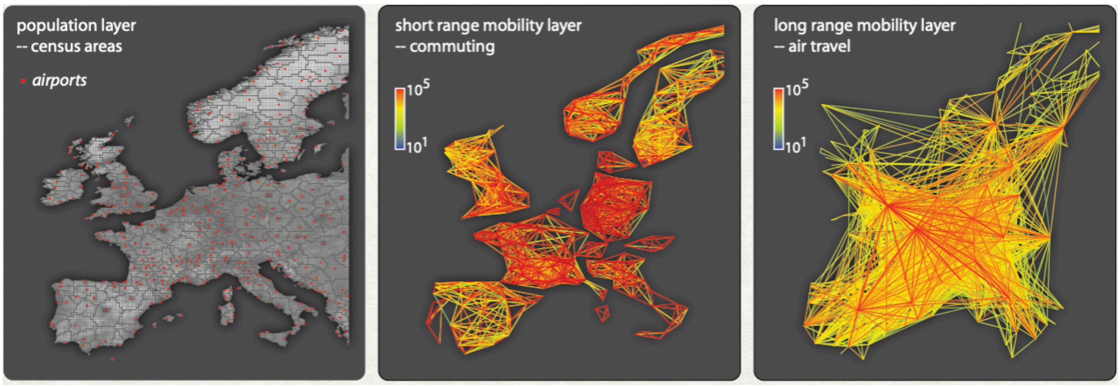

Figure 5-2: The basic data layers embedded in GLEAM

In order to allow the use of the computational epidemic models to a wide audience of policy makers, scientists and educators, ISI has developed a client-server application, named GLEAMviz, giving access to the design of global-scale scenarios of infectious disease spreading threats. The tool allows a general and flexible description of disease dynamics and the accurate specification of many additional parameters to describe intervention and mitigation policies. Using as inputs available data about number and location of detected cases and pathogen(s) information, the tool can help in understanding observed epidemic spreading patterns and analyse response plans, available to researchers, healthcare professionals, and policy makers.

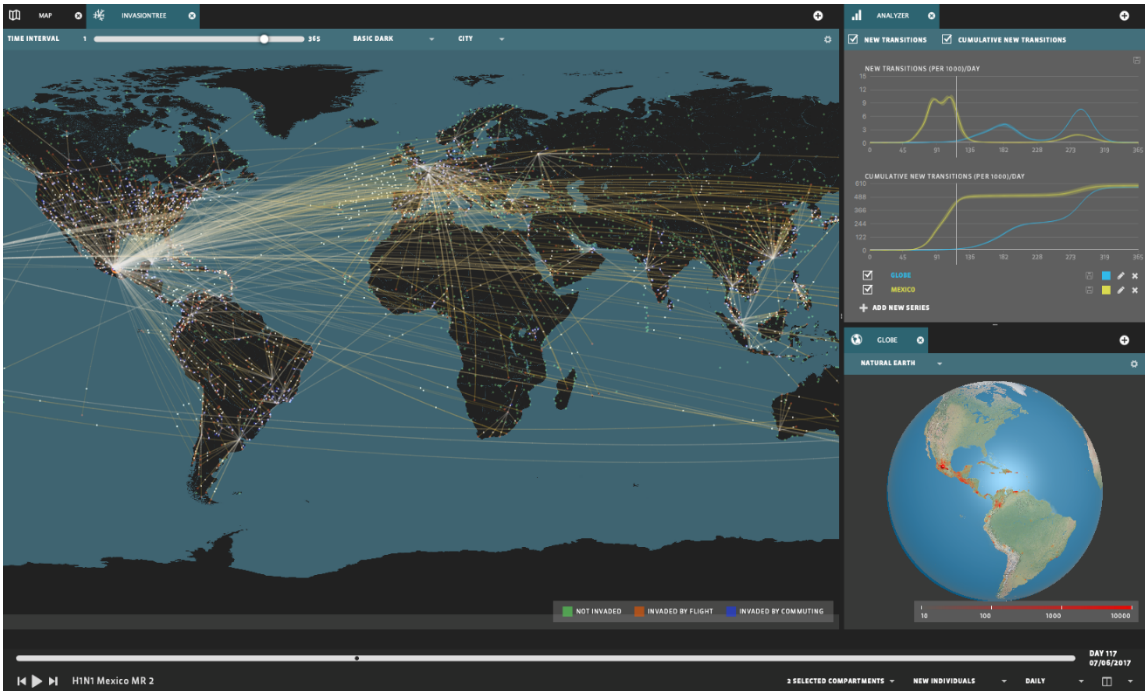

Figure 5-3: The GLEAMviz Dashboard showing airline infection patterns

This research approach and the modelling framework can be applied to the study of emerging epidemics and other disease spreading processes. That requires knowing initial conditions, writing the effective equations and performing simulations.

5.2 Demonstrator Scenario: Improved modelling of infectious disease spreading based on aviation data

The main objective of the ISI demonstrator is to implement non-incremental improvements to the current models by integrating additional available aviation-related data, like travellers' age structure, gender and income data. The process requires to characterize statistically these data sets and model the real-world processes that produced the data. Using data stratified with the above additional information will allow us to considerably improve the accuracy of the modelling approach and study indicators not previously accessible in the simulated scenarios. The ISI demonstrator aims at assessing both qualitatively and quantitatively the novel modelling capabilities, analysing the accuracy of the predictions in historical and current epidemic forecasts.

A first focus of the demonstrator will be the integration of age stratified traveling data. Working with age stratified data will allow the explicit use of epidemic models considering differences in mobility and interactions across different age brackets for individuals. More specifically, in addition to the parameters describing the disease transmissibility, one of the key elements needed to move to the next level of accuracy the computation of the dynamic of the epidemic in the populations consists of contact matrices that are constructed by considering the interactions of individuals belonging to different age groups. Such a modelling approach requires a greater level of detail concerning both the demographics corresponding to each subpopulation and the data on human mobility, most important among those is the information about airline traffic and the related age structure. In this respect, the ICARUS platform shall be a key enabler for establishing the required integration of aviation data.

ISI will apply the stratified models to a well-studied real case scenario – the 2009 H1N1 flu pandemic, for which detailed data are available - performing an extensive exploration of the simulation parameters and comparing the outputs for different countries and regions in the world, in order to validate the model and assess the accuracy of the results. Some other possible applications might be considered depending on the available data extent and the results of the fundamental validation scenario, e.g. the MERS outbreaks in Saudi Arabia and/or Korea, the Ebola outbreak in West Africa, the Zika outbreak in the Americas, etc.

In this context, it is worth remarking that while airline mobility is the key driver of the international spread of diseases, at the same time travel restrictions and advisories due to epidemic threats lead to important decline in air traffic, seriously affecting the airline industry. During the H1N1 pandemic in 2009, a decrease (about 40%) in international air traffic to/from Mexico has been observed. More recently, the CDC Zika alert in 2016 led to a 10% decline in the traffic to the Caribbean and Puerto Rico. Passenger stratification data will enable the epidemic model to provide indications on the changes in air passenger in/outflow to/from specific regions or countries in case of major infectious disease threats. In particular, based on the detailed attack rates on stratified population and comparative propensity of taking health-related risks (being highest for young adults), it is possible to estimate the rate of avoidance in specific age groups of traveling in disease affected areas when travel warnings are issued. Consequently, it is possible to estimate the passenger decrease rate among specific areas, which then affects revenues and passenger load factor for companies serving such routes. In other words, economic losses to various aviation players due to the disease and travel restrictions, both authority-induced and self-imposed, become quantifiable.

To assess the accuracy of the improved modelling framework exploiting age-stratified data, the ISI demonstrator will also perform extensive comparisons of the results provided by the simulations with the historical time series of several US and European countries seasonal flu epidemics, based on official values from the *Influenza-like Illness Surveillance Network* (ILINet), run by the Centers for Disease Control and Prevention. In order to evaluate the accuracy of each forecast, a logarithmic score will be used, defined as $S(Model) = \ln(\Sigma(Pi))$, where the sum of probabilities Pi (given by the model) is performed over a suitable number of temporal bins chosen according to the quantity considered (e.g., peak weeks, percentage of visits to hospitals, ...) and the corresponding actual weighted ILINet value. By comparing those logarithmic scores, an estimate of the forecast performance will be obtained in terms of expected peak week for the improved model with respect to the current one. The focus will be on the logarithmic score because of its operational use by major national and international health agencies; however, performance indicators such as the Maximum absolute percentage error (MAPE) and the overall correlation coefficient of the final estimated and actual epidemic time series, will be also reviewed. ISI anticipates improvements in performance of the model with an increase of more than 10% in the logarithmic scores. Furthermore, the new modelling framework and platform will allow the investigation of additional indicators such as the relative decrease of passengers among connections in the case of infectious disease advisories.

Due to the difficulties of collecting detailed data about passenger stratification directly from the aviation players, the ISI demonstrator envisions two approaches for the execution of this scenario: a basic implementation and an improved one. In the first case, ISI will exploit updated datasets about population and airline traffic, together with official reports about passenger demographics coming from offices of statistics at the country level, to develop an upgraded version of its computational model. In the advanced approach, ISI shall explore detailed passenger demographics originating from the airline booking systems, and use them to design the modelling framework with a full coupling between human mobility and intra-population interactions.

In addition, ISI is also exploring the possibility of extending the scenario with additional data about return bookings and tickets, as a proxy for average length of stay. This would allow testing alternative modelling approaches exploring the time scale separation and effective interaction between “fast“ short-distance commuting and “slow” long-distance travel modes.

5.2.1 Current Challenges

The GLEAM epidemiological simulation framework strongly relies on the level of detail of the mobility data integrated into the model. Improving such level of detail would result in more accurate epidemic predictions, however the availability of additional information regarding individual travel routes and travel behavior by age and gender is usually not available to research institutions because of the costs associated to the dataset. Over the years, ISI has faced difficulties in establishing profitable channels to gather such datasets. The basic challenge for this demonstrator is thus to effectively locate, collect and explore reliable data about human mobility, with a sufficient geographical coverage and resolution. This condition is a pre-requisite for developing a proper model and assessing its performance. The subsequent major challenge is the design of the appropriate data integration framework in the computational modeling platform. Finally, exploring the results and validating the modeling approach by comparing with various epidemic scenarios could raise unexpected questions to be addressed.

5.2.2 Business Objectives

This demonstrator scenario aims at assessing the dependence of the attack rate (overall number of infections in a population) and its public health, demographic and economic impact on population demographics linked to airline mobility data. Census information for the various sub-populations shall be matched with age-stratified aviation data about passengers, refining the development of containment strategies and intervention measures. It would also allow introducing age-related behaviour traits of passengers (such as risk aversion across different age brackets of the population), and evaluate travel-restriction measures directly affecting the aviation industry. The performance of the resulting modelling framework will be assessed against real data from current and past infectious disease epidemics (estimates of number of cases, diffusion times, etc.).

As an additional output of the demonstrator scenario we plan to provide insight on the economic impact of an epidemic on the aviation industry, by estimating the reduction of travellers on the airline mobility network. Using the improved computational framework, ISI will simulate the relative decrease of passengers according to the class. Results will be first validated comparing the model simulations for real-world epidemics for which we have data about impact on aviation transport industry, like the 2009 H1N1 flu pandemic. By collaborating with various aviation players (airlines, airports, ground service providers, etc.), ISI expects to provide relative estimates of the revenue losses to be expected in different epidemic scenarios. Coupling detailed epidemic spreading models with the market analysis of airline transportation is to our knowledge still a largely unexplored area that opens a fertile ground for future research and exploitation of the ISI demonstrator.

Thanks to the ICARUS project, involving and attracting important players of the aviation sector, ISI aims at acquiring the detailed information needed carry out the proposed research and development activities.

5.2.3 Interaction with the Aviation Value Chain

This demonstrator belongs mostly to the 3rd tier of the ICARUS data value chain, focusing on health-related issues, which in turn might affect aviation and ground services operations (2nd/1st tier). The connection with the aviation industry is indirect, but this scenario highlights how different phenomena are indeed related and mutually dependent, forming an interconnected complex system. Human mobility through the aviation infrastructure affects strongly the spreading of infectious diseases, which in turn affects human mobility and hence the aviation industry.

Table 5-1: ISI Scenario Actors' Involvement

Level	Actor Type	Interaction Details
1	Airlines	Collect, aggregate and provide stratified passenger data
2	GDS, Booking systems	
2	Aviation Authorities, Statistics Offices	Collect and explore available open data that are related to passenger stratification
1	Airlines, Airports, Ground handlers	Interact to estimate relative revenue losses to be expected in different pandemic scenarios

5.2.4 Business Processes: AS-IS and TO-BE

In the current implementation of the meta-population simulation framework, the model is considering individuals as indistinguishable except for their disease-related status. ISI has been working on extending the intra-population disease dynamics in order to consider age-stratified population and model the contagion process among individuals as peculiar to each age-bracket. This approach would require matching the stratified intra-population contact patterns with the stratified inter-population mobility processes. Implementing this coupling would also grant the fundamental requirements for enabling a full integration with local agent-based models, like the ones ISI is currently using for many European countries, thus allowing the extraction of high-resolution output data.

Table 5-2: ISI Scenario Business Processes

Scenario	Improved modelling of infectious disease spreading based on aviation data
Business Process	Exploit targeted aviation data (e.g. passenger stratification)
AS-IS Situation (Before ICARUS)	**TO-BE Situation (With ICARUS)**
Individuals are indistinguishable except for their disease-related status. Demographics data in sub-populations cannot be related to mobility fluxes, so ad-hoc assumptions are made to make the model numerically tractable. The output of statistical analysis does not take into account explicitly the age-distribution of the population.	The disease model is stratified and there is a coupling between intra-population interactions, described by contact matrices, and mobility fluxes. Stochastic simulations are run introducing additional dimensions based on aviation mobility data acquired with the help of ICARUS. Population stratification applies both to the disease dynamics occurring within each sub-population and to the data-driven mobility simulations. Intervention strategies can be modelled according to realistic age distribution patterns and the output analysis can explore and highlight correlations and dependencies impossible to study under the current modelling assumptions. Economic impact estimates due to pandemic scenarios are provided for various stakeholders.
Critical ICARUS Features	• PLATF_F_01 Retrieval of data directly from an aviation stakeholder's back-end system • PLATF_F_06 (Semi-)Automatic quality check of the data and assessment of quality level

	• PLATF_F_15 Easily applicable data cleaning methods • PLATF_F_18 Searchability and identification of related additional data assets • PLATF_F_20 Indication of the linkable denominators, upon which linking of the data assets can be performed • PLATF_F_21 (Semi-)Automatic data asset linking • PLATF_F_22 Definition of simple and advanced "information" queries • PLATF_F_26 Access and inspection of data assets "extracts" depending on their license • PLATF_F_48 Delivery of notifications regarding new data assets checked in, and/or existing data assets updated, related to own data assets or to analysis and visualisations performed • PLATF_F_49 Delivery of notifications regarding updates and modifications in the terms of use (e.g. licences) of data assets exploited through the platform • PLATF_F_57 Negotiation of a data sharing agreement • PLATF_F_61 Acceptance of terms of use of a public data asset and availability to download

5.2.5 Test Cases

The test cases for this demonstrator, due to the peculiar scientific context, are mostly related to the opportunity of exploring and exploiting airline passenger data to enhance the understanding of global and local disease spreading phenomena, bringing public benefits to the community.

A preliminary analysis of the economic impact of pandemic scenarios on the aviation industry (airlines, ground services, etc.) shall be conducted and the results be made available through the ICARUS platform.

Table 5-3: ISI Scenario Test Case 1

Test Case	Explore data assets related to flights schedules, passengers and travel types
Actors	ISI user
Importance	High
Pre-conditions	ISI user shall be a valid user (successfully registered in the ICARUS platform) and be logged in
Post-conditions	Aggregated passenger data are available to be used for the epidemiological modelling framework
Workflow	1. ISI user searches for available data about passenger stratification, flights and/or travel types to use for the novel modelling framework 2. Applies filtering options to identify the needed data 3. Finds a proper dataset 4. Checks that licensing conditions are appropriate 5. (Optional) Follows recommendations to identify additional useful datasets
Alternative Flows	3b. No proper dataset is found
Related ICARUS Phase	*Data Collection, Asset Exploration & Extraction, Asset Sharing*
Success Indication	The required dataset is available and fitting the modelling needs.
Failure Indication	Data asset is not available, the terms are not allowing the intended use by ISI (e.g. it is not downloadable).

Notes	-

Table 5-4: ISI Scenario Test Case 2

Test Case	Acquire aviation-related data of interest
Actors	ISI user
Importance	High
Pre-conditions	ISI user shall be a valid user (successfully registered in the ICARUS platform) and be logged in
Post-conditions	Aggregated passenger data can be used by ISI user
Workflow	1. ISI user files a request through the platform to get the aviation data of interest, to their respective provider 2. ISI user receives a draft contract from the data provider 3. ISI user checks the contract terms (especially if it prohibits local download of the data) 4. ISI user accepts the terms of use and signs the contract in the ICARUS platform 5. ISI user has access to the data acquired
Alternative Flows	2b. The dataset is not going to be shared by the provider 4b. ISI user rejects the terms of the contract 4c. The terms of the contract request payment for the data (if provided by external - to the consortium – stakeholders)
Related ICARUS Phase	*Data Collection, Asset Exploration & Extraction, Asset Sharing*
Success Indication	The required dataset could be accessed by ISI.
Failure Indication	Data asset is not available, the terms are not allowing the intended use by ISI (e.g. it is not downloadable).
Notes	-

Table 5-5: ISI Scenario Test Case 3

Test Case	Download locally aviation-related data of interest
Actors	ISI user
Importance	High
Pre-conditions	ISI user shall be a valid user (successfully registered in the ICARUS platform) and be logged in
Post-conditions	Aggregated passenger data can be downloaded and inserted in the epidemiological modelling framework
Workflow	1. Downloads locally the aviation related data of interest (i.e. age-stratified passenger data) on the On Premise Environment 2. Decrypts the available dataset on the On Premise Environment
Alternative Flows	-
Related ICARUS Phase	*Data Collection, Asset Exploration & Extraction, Asset Sharing*

Success Indication	The required dataset became locally available and ready to integrate into the epidemiological modelling framework.
Failure Indication	Data download fails.
Notes	-

Table 5-6: ISI Scenario Test Case 4

Test Case	**Be notified about relevant assets**
Actors	ISI user
Importance	Low
Pre-conditions	• ISI user shall be a valid user (successfully registered in the platform) • ISI user has specified on the ICARUS platform his/her preferences
Post-conditions	Related data are found by ISI
Workflow	1. The ICARUS platform notifies the user of the availability of new potentially interesting assets 2. ISI user browses the new assets description and metadata 3. ISI user has access to some data extracts/samples *4.* ISI user checks the licensing options
Alternative Flows	-
Related ICARUS Phase	*Data Notification, Data Linking, Data Exploration*
Success Indication	ISI user is aware of the new datasets or analytics and has successfully evaluated his/her interest
Failure Indication	Not interesting assets are suggested, or valuable ones are ignored
Notes	-

5.2.6 Data Availability and Needs

The availability of additional detailed passenger demographics is crucial for developing this scenario. According to the specific data characteristics in terms of spatial extension, granularity, temporal extension etc. a proper modelling approach shall be adopted in order to pursue the scenario objectives. The acquisition of age-stratified passenger data from a Global Distribution System provider is currently under investigation, thanks to the collaboration with the OAG partner. As previously mentioned, optional data about average length of stay during travel (time distribution between date of departure and date of return) could be used to further enrich the scenario.

Table 5-7: ISI Scenario Data Available Overview

ID	Data Asset Title	Data Provider	Criticality
ISI_01	Population Data	Open data (Columbia University)	Y
ISI_03	Infection data	Open data (WHO, ECDC, …)	Y

Table 5-8: ISI Scenario Data Needed Overview

ID	Data Asset Title	Data Provider	Criticality	Status
ISI_DR_01	Origin-Destination bookings	OAG (GDS)	High	Already available and used due to a private purchase before and outside ICARUS
ISI_DR_02	Passenger stratification	Open Data + GDS (via OAG)	High	The acquisition of this asset is currently under investigation
ISI_DR_07	Survey of International Air Travelers	CIC Research / NTTO	High	The acquisition of this asset is currently under investigation

More detailed information about the data available and needed is provided in the ICARUS Deliverable D1.1 "Domain Landscape Review and Data Value Chain Definition" and shall be updated in the forthcoming Deliverable D1.3 "Updated ICARUS Methodology and MVP WP1".

5.3 Considerations, Constraints and Preconditions

The availability of new datasets is fundamental for a non-incremental progress in the modeling framework. The scenario will benefit from and will build upon the existing computational infrastructure; the core data structures used by the GLEAM system will be updated according to data availability (population, mobility).

The described scenario focuses mainly on one aspect of passenger demographics (age). Depending on datasets availability and their features, other modeling approaches and characteristics might be tested, assessed and implemented. The critical issue is the availability and accessibility of the relevant data, and their completeness. ISI is working together with the consortium to access information sources that can be used to enhance the epidemiological modeling infrastructure.

A major effort could be needed to review, adapt or redesign the modeling infrastructure depending on the heterogeneity of the datasets and their compatibility with the current modeling framework.

5.4 Business Impact and Expected Benefits

Thanks to the collaboration with prominent players of the aviation industry, the specific demonstrator aims at improving the modeling capabilities of the epidemiological framework that ISI has been building over the years. The research performed so far has led to the development of a modeling framework and computational tools focused on the study of infectious disease spreading, and the analysis that has been performed have been used in many real-case scenarios, often responding to a need from major public health agencies. The ICARUS project could allow ISI to collect important data about human mobility, more refined and more updated than the ones that are currently considered state of the art in the modeling community, and thus significantly improve our framework and its forecasting capabilities.

The ISI demonstrator aims at assessing the attack rate dependence on the age structure of the population and potentially on other factors like wealth status, gender, travelling habits, etc. It particularly plans to study the efficacy of containment strategies and intervention measures developed and targeted according to age. ISI will estimate the performance of the extended model in evaluating various epidemiological parameters, like attack rate, peak time, etc. Additionally, according to the available data, an analysis of the economic impact of an epidemic on the airline industry based on the attack rate on stratified population shall be performed and offered back to the aviation industry through the ICARUS platform.

Overall, through ICARUS, the ISI demonstrator expects to improve the modeling and prediction accuracy of the GLEAM infrastructure, in terms of quantitative epidemiological and economic indicators, deepening our understanding of disease spreading, and providing evidence-based tools for the management of infectious disease threats.

Table 5-9: ISI Key Performance Indicators

Scenario	KPI	Calculation Method	AS-IS Value	TO-BE Value	Verification Means
1	Improved assessment of case importation	[[Accuracy of case importation with the extended model] – [Current case importation accuracy]] / [Current case importation accuracy]	95% CIs for the risk of case importation in 232 countries	10% accuracy improvement for a real case pandemic scenario	Comparisons of risk importation show significant increase in accuracy
1	Seasonal flu peak time logarithmic score	[[Logarithmic score with extended model] – [Logarithmic score with current model]] / [Logarithmic score with current model]	Computed peak weeks score uses ILInet values	10% increase of the score for several US flu seasons	Computing the logarithmic score with the stratified model we obtain a ≥10% increase
1	Detailed mobility simulation with additional parameters (e.g. age)	Additional parameters are used to extend the simulation of human mobility	-	+1	Disease dynamics and mobility take into account stratification while performing simulations. Simulation output results provide detailed information per additional parameter.
1	Improved flow reduction computation to provide	Additional output about stratified passenger flow reduction is produced by the simulation framework	-	Stratified flow reduction with 95%	Compare traffic reduction with a real case pandemic scenario

Scenario	KPI	Calculation Method	AS-IS Value	TO-BE Value	Verification Means
	better estimate of the economic impact of an epidemic			confidence interval	

5.5 Demonstrator Execution Plan

1. Data exploration and collection.

The platform will continuously be explored searching for datasets of interest, with a particular focus on passenger mobility data, looking for updated and detailed assets.

This step is devoted to acquiring the appropriate datasets by contacting data providers and establishing a profitable interaction, a process that requires great efforts and care. ISI aims to collect and gather data about passenger stratification in terms of age distribution, e.g. aggregation in 5-years bins for a reasonable subset of the mobility network (routes, bookings, carriers, etc.).

2. Data pre-processing and cleansing.

The datasets will be analyzed to devise a proper adaptation and/or conversion to a format suitable for inserting into the epidemiological models. Data shall be adapted, cleaned and extended when missing or incorrect. Then we shall project the information at the global scale for all the connection links we have in the model: collaboration with other partners with expertise in this kind of processes, like OAG, could be helpful in figuring out the best way to perform the extension.

3. Update modeling approach.

The design of the modeling approach shall be reviewed and possibly upgraded according to the newly available data, including the fundamental equations and the simulation workflow.

4. Code adaptation.

The simulation code will be adapted in order to handle the adjourned demographic structure, both in the local sub-populations, by means of detailed contact matrices, and in the long range mobility procedures (using age-brackets), based on the newly available datasets. The new data-driven modeling infrastructure using stratified disease diffusion procedures will be implemented.

5. Data importation and model validation.

The adjusted stratified mobility dataset will be imported and used by the extended modeling framework. The new code shall be tested and the results validated comparing with former/historical data, using at first for this purpose the 2009 H1N1 flu pandemic. The system performances will be analyzed. This is an iterative process aimed at optimizing the modeling capabilities.

6. Scenario assessment.

The scientific question at the core of the scenario design is going to be assessed and tested, evaluating the forecasting performances of the extended model considering, in particular, time accuracy and demographic resolution. Multiple case settings will be explored; the attack-rate dependency on the age stratification will be analyzed, together with the potential effect of targeted intervention strategies. The effect on the global transportation network due to a pandemic outbreak shall be studied. An analysis of the economic impact of an infectious disease epidemic on the aviation industry will be performed, combining flow decrease information with the available data from various stakeholders (airports, airlines, etc.).

The improved models taking into consideration passenger age distributions will be tested with suitable real case pandemic scenarios, like the mentioned swine flu epidemic, the MERS outbreaks in Saudi Arabia and/or Korea, and seasonal flu data. An extended set of simulations will be run according to each real test case scenario, performing in depth comparison with historical data and with the output of the former computational model, in order to validate predictions and assess accuracy. Depending on the preliminary results additional scenarios might be explored in order to investigate specific hypothesis about the correlation of epidemiological parameters with age stratification.

Table 5-10: Demonstration Activities for ISI

Demonstration Activities	**M15**	**M16**	**M17**	**M18**	**M19**	**M20**	**M21**	**M22**	**M23**	**M24**	**M25**	**M26**	**M27**	**M28**	**M29**	**M30**	**M31**	**M32**	**M33**	**M34**	**M35**	**M36**
1 Data exploration and collection																						
2 Data preprocessing																						
3 Update modeling																						
4 Code adaptation																						
5 Model validation																						
6 Scenario assessment																						

6 Demonstrator IV: CELLOCK

6.1 Business Context

Passenger experience enhancement is a widely discussed topic in aviation, with all involved parties, from airlines and airports to ground handling companies and caterers, looking to optimize their services and product offerings for its achievement. CELLOCK provides services to airlines and caterers and there is great interest from their side to evaluate their current status and improve any weaknesses spotted.

CELLOCK provides a complete inventory and warehouse management system, accompanied by portable Point-of-Sale (POS) devices for the crew on board. The system, named **BoB (Buy-on-Board),** is used by both caterers and airlines: caterers use it for the warehouse management, monitoring all their product stock and handling all plane loadings, including Food and Beverages (FnB) trays as well as Duty-Free/Sales-on-Board trays. Airlines use BoB for inventory and sales monitoring.

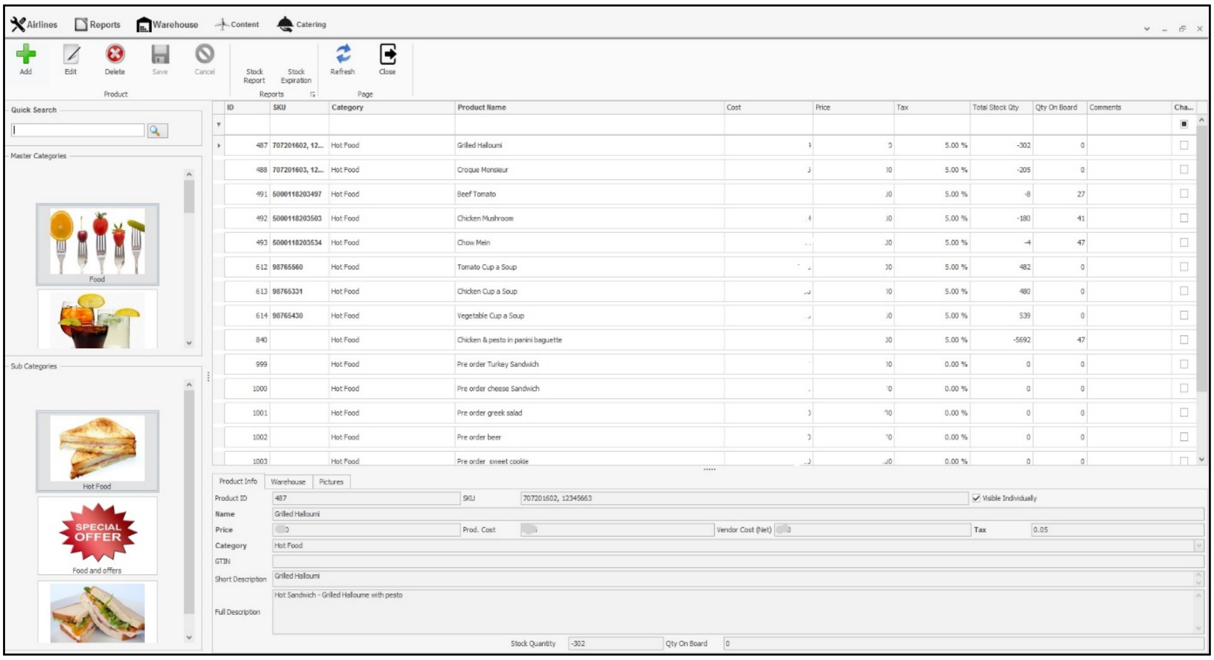

Figure 6-1: CELLOCK's BoB (Buy-on-Board) products page

The system offers the option to plan tray loadings either per flight segments or per whole day, provided that the tray loadings and number of flights allow this.

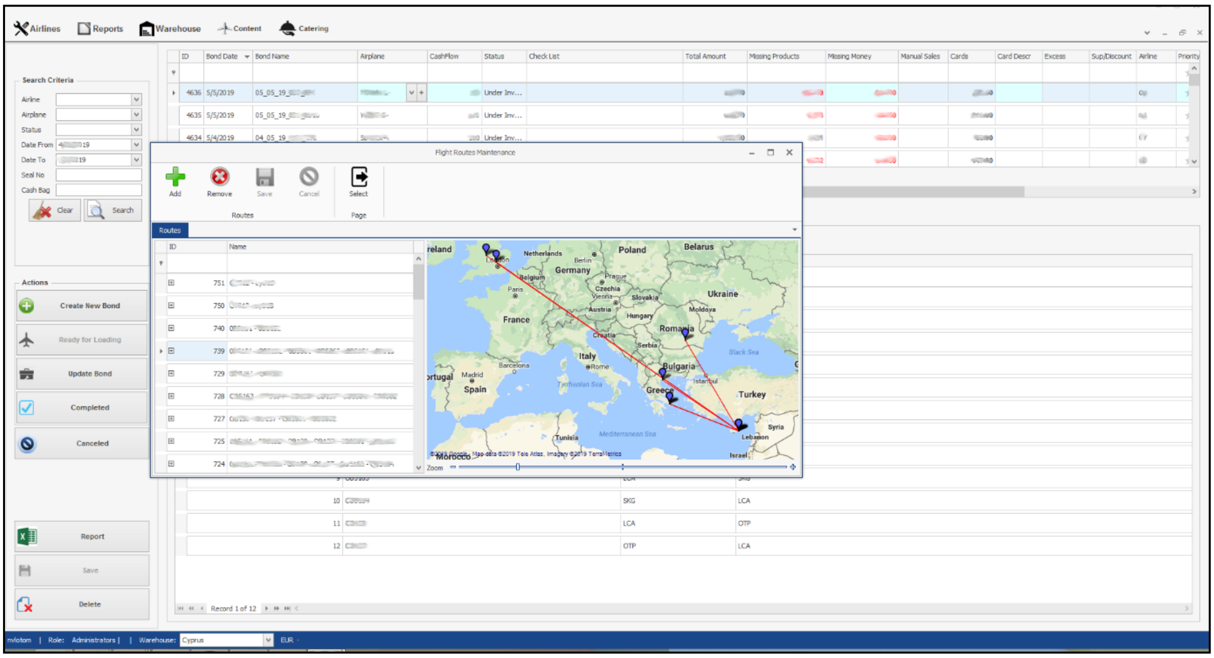

Figure 6-2: CELLOCK's BoB (Buy-on-Board) bond loading page

The crew is equipped with portable devices running the "Crew app" of the software, handling all FnB and Duty-Free sales. Using the Crew app, the crew can monitor the loaded trays and products stock on-board, report for missing or damaged items as well as receive payments for sales in cash or by cards and in multi-currencies. Both the system and the Crew app are PCI certified and all data gathered are anonymized, while sensitive data are well secured and protected from unauthorised access.

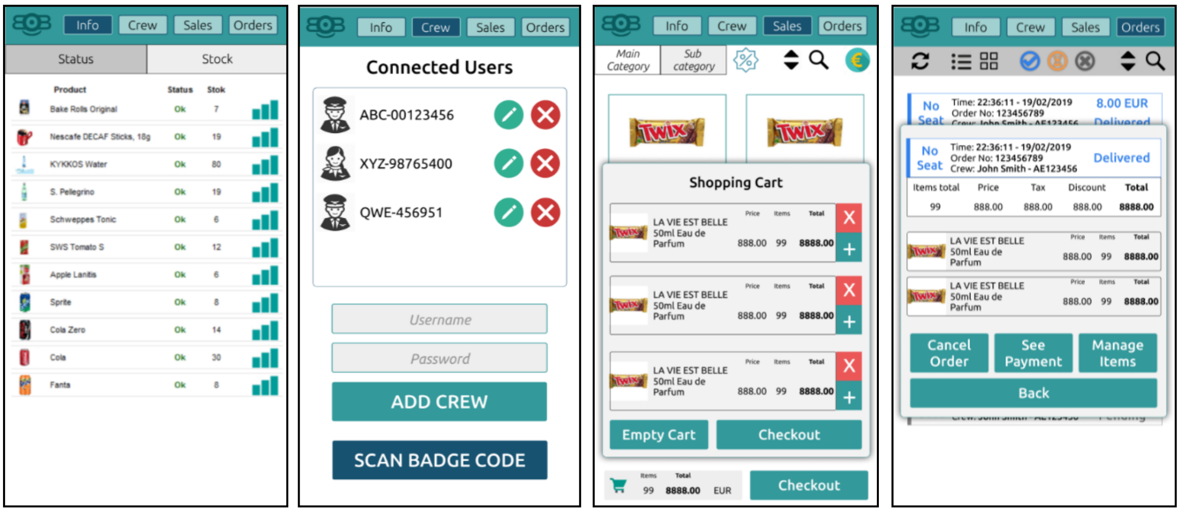

Figure 6-3: CELLOCK's Crew App

BoB supports a wide number of pre-built reports, while both the caterers and the airlines can create customized reports to accommodate their needs.

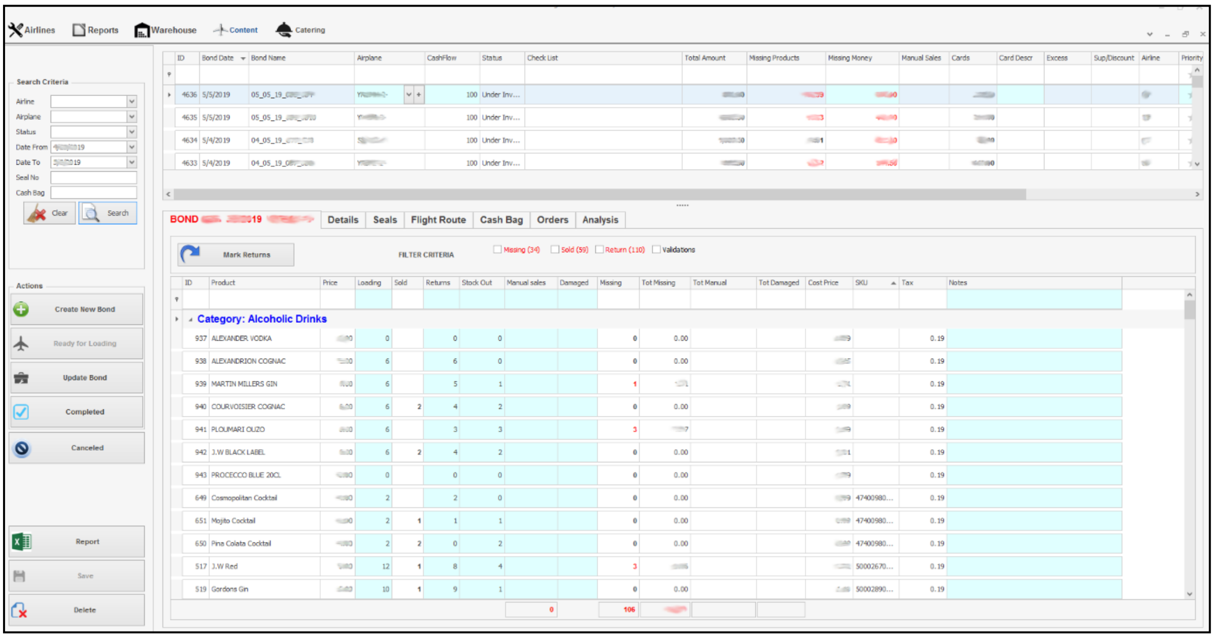

Figure 6-4: CELLOCK's BoB (Buy-on-Board) sales page

The users of BoB can also get extensive visualized results, based on the reports created. This provides a quick overview on the predefined reports, as well as the customized ones, such as sales achieved by flight or destination.

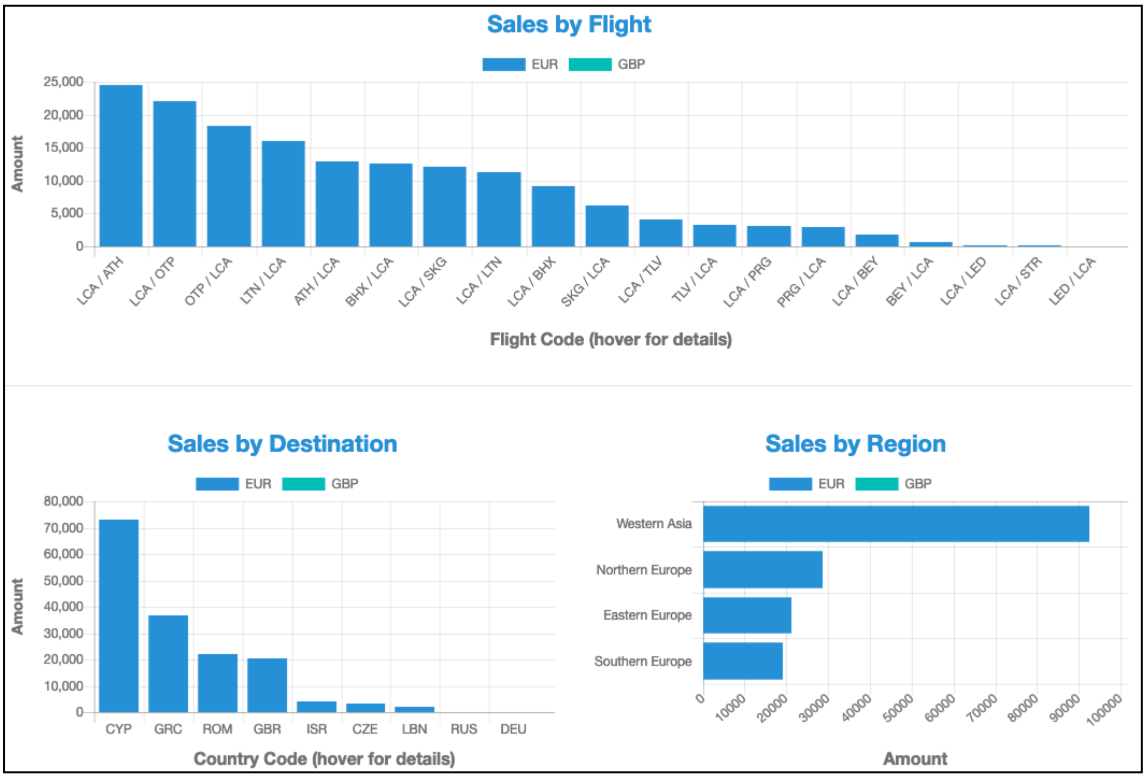

Figure 6-5: CELLOCK's BoB (Buy-on-Board) sales visualization pages

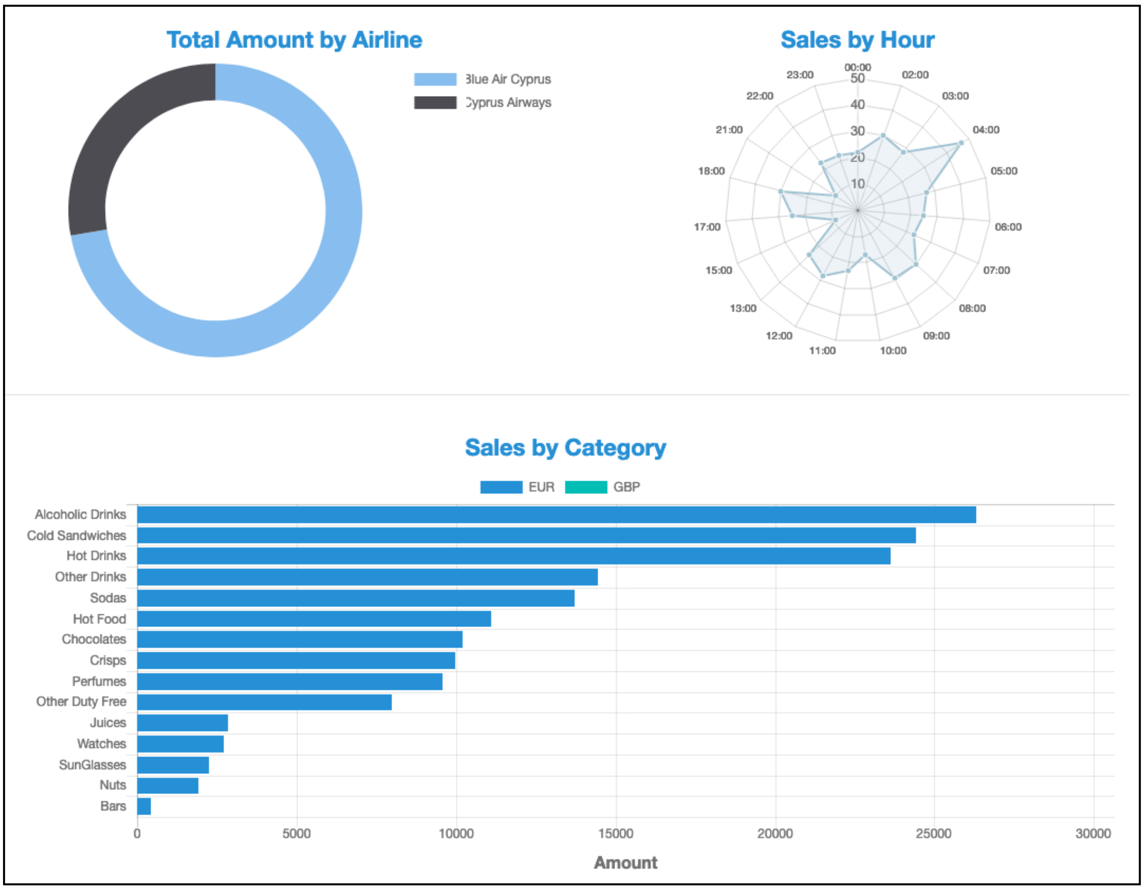

Figure 6-6: CELLOCK's BoB (Buy-on-Board) sales visualization pages

Figure 6-7: CELLOCK's BoB (Buy-on-Board) discrepancies visualization graphs

CELLOCK will prepare and demonstrate 2 scenarios within the ICARUS project. The aim is to enhance the existing analytics engine within the BoB system, by adding prediction capabilities for airlines and caterers to improve their service efficiency. More specifically, this has the following results:

1) **Reduce cabin food waste and increase revenue**. This can be achieved by targeting the reduction of weight loaded on-board the aircraft, inventory management for decreasing load and increasing crew sales performance. Nowadays in the aviation industry, more and more products are sold inflight, while a huge amount of food waste happens in every flight. In addition, carts holding the food and beverages in-flight are heavy, including the catalogues which are adding to the load of the aircraft, "*Anything that isn't sold is dead weight. Inventory management is a challenge in the air, forecasting and restocking difficult".*[3]According to Lufthansa, the fuel consumption in 2016 was 3.85 litres per 100 passenger kilometres[4] with Delta reporting 4.2l/100pkm[5] and Emirates 4.3l/100pkm[6]. According to ICAO and IATA[7] *"…an average mass of 100 kg for a passenger plus its checked baggage better reflects today's actual values."* Moreover, the average tray weight is also approximately 100 kg, therefore, one can relate the fuel consumption rate for a loaded tray being close, if not identical, to passenger-kilometre estimations. Reducing the number and weight of the trays, the airlines can optimize their fuel consumption as well as CO2 emission rates without affecting the quality of their offered services on-board.
2) **Predict profitable discounts and offers to increase inflight sales.** In this scenario, despite the obvious direct benefits for the airlines and caterers, indirectly the passenger experience will be also enhanced by providing offers to the passengers, that will be related to their overall journey, destinations, weather etc. This will be achieved by thorough analysis on historical data of product sales and bundle offers on the products already available on-board, both FnB and Duty-Free. Nowadays airlines, especially the low-cost ones, are literally supported by the on-board-sales ancillary revenues, due to the minimum profit margin of the ticket sales, according to ECTAA (European Travel Agents and Tour Operators Association). Moreover, offering customised discounts and offers to passengers, increases their satisfaction and travel experience.

It needs to be noted that after many iterations and brainstorming discussions, the CELLOCK demonstrator scenarios have focused on the inflight experience and have thus slightly diverted from the broader "Enhancing Passenger Experience" scenario that was described in an end-to-end manner (Pre-flight, Inflight, Post-flight) in the ICARUS DoA. This change is due to the need to build on existing demonstrators' software products /solutions and link the demonstrators' own baseline data with other aviation-related data in order to ensure the future results' exploitation and their seamless execution during the project duration.

[3] https://www.inmarsataviation.com/en/benefits/revenue-opportunities/the-future-of-inflight-retail.html
[4] https://www.lufthansagroup.com/fileadmin/downloads/en/responsibility/LH-sustainability-report-2018.pdf
[5] http://www.corporatereport.com/delta/2016/csr/Delta_2016_CSR.pdf
[6] https://cdn.ek.aero/english/images/environment-report-2016-17_tcm233-4662773.pdf
[7] https://www.icao.int/Meetings/STA10/Documents/Sta10_Wp005_en.pdf

6.2 Demonstrator Scenario 1: Prediction of sales on-board and tray loading suggestions

The 1st scenario aims to enhance the existing analytics engine within the Cellock's BoB system, by adding prediction capabilities for catering service companies (2nd tier stakeholders) and airlines (1st tier) in order to optimize the loading weight of the duty-free and catering trays on board, prior to the flight, while reducing the cabin food waste. Saving on the number and weight of the trays, the airlines can optimize their fuel consumption as well as CO2 emission rates without compromising the quality of their offered services in flight. On that scenario, very recently Singapore Airlines announced[8] the launch of a new sustainability initiative *"…that will significantly reduce the carbon footprint and improve the sustainable travel experience of the customers."* To achieve this, the airline will introduce Machine Learning and Artificial Intelligence, to predict ***travellers' consumption patterns and reduce cabin food waste***, according to the announcement. As described above, the reduction of cabin food waste is a major need for airlines for scenario 1, and more specifically for a Cellock's BoB enhanced product.

6.2.1 Current Challenges

The main issue which both caterers and airlines currently face, is the quite challenging inventory management as well as forecasting and loading the day-to-day operations. The prediction of unconsumed products and the waste generated on board, the time that will happen, in which destination and route, is a major challenge for airlines and caterers.

Additionally, the duty-free trays are even more difficult to organize and predict. Most commonly, the duty-free trays are loaded with the same items based on a static list, the in-flight sales are minimum and return to base practically untouched, justifying the 1.5% annual sales reduction according to Inmarsat Aviation[9], as mentioned above. Uplift costs of goods are also a challenge since they keep increasing depending on the airport and the number of carts (items).

6.2.2 Business Objectives

CELLOCK's BoB has access to a large volume of data, which are daily updated. BoB offers the option of creating customised reports, to reveal trends based on the collected data. It is expected that BoB will become a valuable tool for Cellock and its partners with the implementation and integration of predictive algorithms and methods, that will suggest optimized tray loadings, in order to improve sales on-board and reduce cabin food waste. Achieving this will also introduce other indirect benefits to airlines and caterers as well as to passengers.

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[8] https://www.singaporeair.com/en_UK/in/media-centre/press-release/article/?q=en_UK/2019/January-March/ne0819-190321

[9] https://www.inmarsataviation.com/en/benefits/revenue-opportunities/the-future-of-inflight-retail.html

Providing predictive capabilities, through Cellock's BoB, to airlines and 2nd tier stakeholders, will give **direct benefits** to stakeholders and Cellock itself by:

- increasing onboard sales
- reducing cabin waste and costs
- reducing tray uplift costs

In addition, several **indirect benefits** can be provided which are:

- reduction of loaded weight (for both FnB and Duty-Free trays)
- reduction of fuel costs for airlines
- reduction of CO2 emissions
- lowering ticket prices for the travellers.

6.2.3 Interaction with the Aviation Value Chain

The execution of the scenario involves interactions among data available to Cellock, through BoB, and stakeholders of the 1st (airlines) and 2nd level (caterers). More specifically, the caterers will be both data providers and asset consumers, while the airlines will be data providers.

Table 6-1: CELLOCK Scenario 1 Actors' Involvement

Level	Actor Type	Interaction Details
1	Airline (as data provider)	Provide data for flight schedules, total passengers
2	Caterer (as data provider and data consumer)	Provide data for products, current loadings, sales on board Purchase product and tray loading suggestions
3	Weather (as data provider)	Provide data for weather data for departure and destination, to examine weather relation on sales

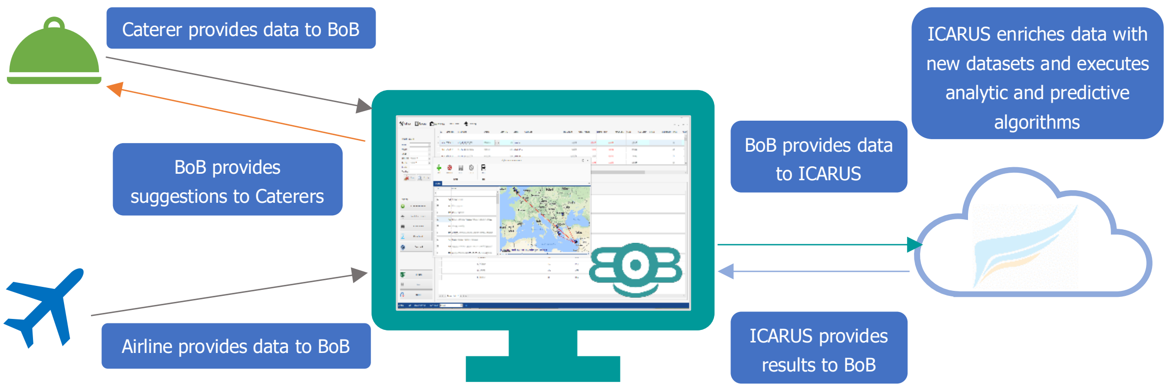

Figure 6-8: CELLOCK Demonstrator Scenario 1 Interactions with Aviation Stakeholders

6.2.4 Business Processes: AS-IS and TO-BE

The scenario will introduce a new, needed feature in Cellock's BoB system analytics, providing suggestions to the end-users regarding the optimization of the Food and Beverage supply chain and Duty-Free tray loadings. Currently BoB contains Business Intelligence for the current products (current sales, missing products and money), while with the implementation of the scenario the enhanced Business intelligence will provide forecasts for the next days, weeks, or months.

Table 6-2: CELLOCK Scenario 1 Business Processes

Scenario	**Product sales analysis**
Business Process	Insights on product sales
AS-IS Situation (Before ICARUS)	**TO-BE Situation (With ICARUS)**
Duty-Free Products are loaded based on a static list Duty-Free trays are loaded for all flight legs of a day FnB Trays are loaded with standard items, without considering the cabin waste created	Upload data from BoB to ICARUS Link with ICARUS relevant datasets Run analytics on historic data Run predictive algorithms Suggest new loadings for FnB and Duty-Free trays Export results per flight
Critical ICARUS Features	(Reference to critical ICARUS Requirements from D3.1 and MVP features from D1.2) ● PLATF_F_02 Uploading of data assets as files extracted by the aviation stakeholder's back-end system ● PLATF_F_18 Searchability and identification of related additional data assets ● PLATF_F_22 Definition of simple and advanced information queries ● PLATF_F_27 Transformation of a data asset to other supported data formats and export ● PLATF_F_28 Navigation to preconfigured analytics ● PLATF_F_29 Definition of an analytic task that runs an individual algorithm ● PLATF_F_30 Definition of a workflow of analytic tasks that combine algorithms ● PLATF_F_35 Execution of an analytics task / algorithm according to specific preferences and settings for computation resources ● PLATF_F_38 Visualization of the analytics results to gain insights on the data and / or comparison how the same results are visualized in different diagrams ● PLATF_F_39 Definition of customized dashboards by selecting which visualizations should appear ● PLATF_F_42 Export of analytics reports as a downloadable file ● PLATF_F_51 Proposition of additional data assets for the enrichment of existing data assets and / or for analysis and visualisation ● PLATF_F_57 Negotiation of a data sharing agreement

6.2.5 Test Cases

The aim of the tests is to verify the operability of the first scenario and to validate the targeted business objectives.

In the specific scenario the tests are:

1. Upload BoB data to ICARUS
2. Browse ICARUS for relevant datasets
3. Link with other relevant data
4. Browse ICARUS for available analytics and applications
5. Design and apply the ICARUS descriptive and predictive analytics
6. Visualize results

Table 6-3: CELLOCK Scenario 1 Test Case 1

Test Case	**Upload BoB data to ICARUS**
Actors	CELLOCK as ICARUS user, ICARUS Platform
Importance	High
Pre-conditions	BoB data available on the On-Premise Environment. Authorization to login to the ICARUS platform
Post-conditions	BoB data are encrypted and stored in ICARUS private user workspace
Workflow	1. Login to ICARUS platform 2. Select option to add dataset as a csv format file 3. Define the data preparation steps in the ICARUS platform 4. Encrypt BoB data in the On-Premise Environment following the data preparation steps provided by the ICARUS platform 5. Upload BoB data to the ICARUS platform *6.* Define data access policies, data confidentiality and data license details
Related ICARUS Phase	Data Collection, Asset Storage
Success Indication	Upload process is completed with a message
Failure Indication	Upload process aborts with a warning message
Notes	-

Table 6-4: CELLOCK Scenario 1 Test Case 2

Test Case	**Browse ICARUS for other relevant datasets**
Actors	CELLOCK as ICARUS user, ICARUS Platform
Importance	Medium
Pre-conditions	Dataset availability in the ICARUS platform

Post-conditions	Select or purchase and view Datasets from other providers
Workflow	1. Login to ICARUS platform and go to the Marketplace page 2. Define data query by keywords, format, data type, etc 3. Run the query 4. Browse the results 5. Preview public datasets and samples of private datasets 6. Select/purchase the datasets of interest 7. Use the new datasets on ICARUS or download them.
Related ICARUS Phase	• Data Exploration • Data Asset Sharing
Success Indication	Purchase process completes with a message
Failure Indication	Purchase process aborts with a warning
Notes	

Table 6-5: CELLOCK Scenario 1 Test Case 3

Test Case	**Link BoB data to other relevant data on ICARUS**
Actors	CELLOCK as ICARUS user, ICARUS Platform, dataset provider
Importance	Medium
Pre-conditions	• User logged in to the ICARUS platform • Cellock data stored in the ICARUS secure and private data space • Relevant datasets available in ICARUS
Post-conditions	Relevant linked datasets stored in the ICARUS secure and private data space for CELLOCK
Workflow	1. Browse through already acquired datasets in ICARUS. 2. Select one or multiple datasets 3. Create links between BoB's dataset and related datasets in the ICARUS secure and private data space
Related ICARUS Phase	• Data Exploration • Asset Storage • Data Enrichment
Success Indication	Linking process completes with a message
Failure Indication	Linking process aborts with a warning message

Table 6-6: CELLOCK Scenario 1 Test Case 4

Test Case	**Browse ICARUS for available applications**
Actors	CELLOCK as ICARUS user, ICARUS Platform
Importance	Medium

Pre-conditions	User logged in to the ICARUS platform BoB data stored in the ICARUS platform and available in the ICARUS private and secure space of CELLOCK Relevant datasets available in ICARUS
Post-conditions	Available applications are displayed
Workflow	1. Login to ICARUS platform and go to the Marketplace 2. Search for applications that use analytical algorithms related to BoB datasets, by keyword, used data or type 3. Browse results 4. Select/purchase the applications of interest
Related ICARUS Phase	● Data Analytics ● Added Value Services
Success Indication	Search process completes without message
Failure Indication	Search process aborts with a warning message
Notes	-

Table 6-7: CELLOCK Scenario 1 Test Case 5

Test Case	**Design and apply the ICARUS descriptive and predictive analytics**
Actors	CELLOCK as ICARUS user, ICARUS Platform
Importance	High
Pre-conditions	User logged in to the ICARUS platform Data available in the ICARUS secure and private workspace for CELLOCK Analytics algorithm(s) available in the ICARUS platform (have already been purchased or selected)
Post-conditions	Analytics results available in ICARUS secure data space
Workflow	1. Login to the ICARUS platform and go to the workspace 2. Select analytics algorithms 3. Select BoB datasets and any other relevant dataset 4. Design the analytics workflow and adjust algorithm options and settings (if needed) 5. Run the analytics workflow 6. Review/save results
Related ICARUS Phase	*From the methodology in D1.2* ● Data Analytics ● Added Value Services
Success Indication	Workflow completes without message
Failure Indication	Analytic workflow aborts with a warning message

Table 6-8: CELLOCK Scenario 1 Test Case 6

Test Case	Visualize analytics results
Actors	CELLOCK as ICARUS user, ICARUS Platform
Importance	High
Pre-conditions	User logged in to the ICARUS platform BoB data available in the ICARUS secure and private workspace for CELLOCK Analytics workflows designed in the ICARUS platform
Post-conditions	Sales prediction visualizations available in ICARUS
Workflow	1. Login to the ICARUS platform 2. Search for available visualizations 3. Select the related analytics workflow that should be visualized 4. Customize chart/visualization options if needed 5. Display the chart/visualization results
Related ICARUS Phase	*From the methodology in D1.2* ● Added Value Services
Success Indication	Visualization is displayed without a message
Failure Indication	Visualization aborts with a warning message
Notes	

6.2.6 Data Availability and Needs

The execution of the scenario requires datasets that are available to CELLOCK, through its BoB system, as well as from 3rd parties, through the ICARUS platform, as summarized in the table below. These datasets contain retail and F&B (Food & Beverage) data from multiple flights a day spreading in over 15 destinations. Datasets with High criticality are vital for the scenario, while the Medium ones will provide useful insights but are not considered absolutely necessary. The Low criticality data do not affect the scenario execution but will improve the overall outcome.

Table 6-9: CELLOCK Scenario 1 Data Available Overview

ID	Data Asset Title	Data Provider	Criticality
CELLOCK_01	Retail and F&B in-flight sales	CELLOCK	High
CELLOCK_02	Number of Passengers	CELLOCK	Medium
CELLOCK_06	Airplane Loading for F & B	CELLOCK	High
CELLOCK_07	Flights Discrepancies	CELLOCK	High

Table 6-10: CELLOCK Scenario 1 Data Needed Overview

ID	Data Asset Title	Data Provider	Criticality	Status
CELLOCK_DR_01	Weather data	Open data	Low	To be available in the ICARUS platform
CELLOCK_DR_03	Aircraft flight routes	OAG	High	To be available in the ICARUS platform
CELLOCK_DR_05	Flight Delays	OAG	Medium	Under investigation

More detailed information about the data available and needed is provided in the ICARUS Deliverable D1.1 "Domain Landscape Review and Data Value Chain Definition" and shall be updated in the forthcoming Deliverable D1.3 "Updated ICARUS Methodology and MVP WP1".

6.3 Demonstrator Scenario 2: Predict profitable product discounts and offers to increase in-flight sales.

The second scenario aims to enhance the existing analytics engine within the Cellock's BoB system, by adding prediction capabilities for airlines (1st tier stakeholders) and catering service companies (2nd tier), in order to suggest discounts and offers targeting to increase in-flight sales.

Currently, BoB stores data on available products, both FnB and Duty-free, as well as data on in-flight sales.

6.3.1 Current Challenges

Currently airlines work with the caterers and select specific products or bundle product offers. The selection criteria are only based on the recommendations of the caterers, which are mostly price and stock based. The product discounts and bundle-offers most commonly run for a period of time, on the whole airline fleet and then are replaced with similar items. The selection process does not take under consideration important factors such as the flight departure and destination or weather conditions/seasonality. Weather conditions is an important factor to sales and especially to food consumption, as generally acknowledged in the bibliography.

6.3.2 Business Objectives

CELLOCK's BoB has access to daily updated data, relevant to in-flight sales, product availability and historical discounts and bundle-offers. It is expected that through data analysis and enrichment with datasets unavailable prior to ICARUS, BoB will be able to provide targeted predictions and suggestions to airlines and caterers on products and bundles that can be offered on discount, while remaining profitable for all involved parties. The **direct benefit** and target is to increase in-flight sales. The additional **indirect benefit** is the satisfaction of the passengers and the improvement of the travel experience, as they will be offered with more relevant FnB and Duty-free products, according to their trip, weather conditions and seasonality.

6.3.3 Interaction with the Aviation Value Chain

The execution of the scenario involves interactions among data available to CELLOCK, through BoB, and stakeholders of the 1st (airlines) and 2nd level (caterers). More specifically, the airlines will be both data providers and asset consumers, while the caterers will be data providers, as summarized in the table below.

Table 6-11: CELLOCK Scenario 2 Actors' Involvement

Level	Actor Type	Interaction Details
1	Airline (as data provider and data consumer)	Provide data for flight schedules, total passengers. Receive suggestions on product discounts and bundle offers.
2	Caterer (as data provider and data consumer)	Provide data for products, current discounts and offers, historical discounts and offers, sales on board. Receive suggestions on product discounts and bundle offers.
3	Weather (as data provider)	Acquire data for weather data for departure and destination, to examine weather relation on sales performance

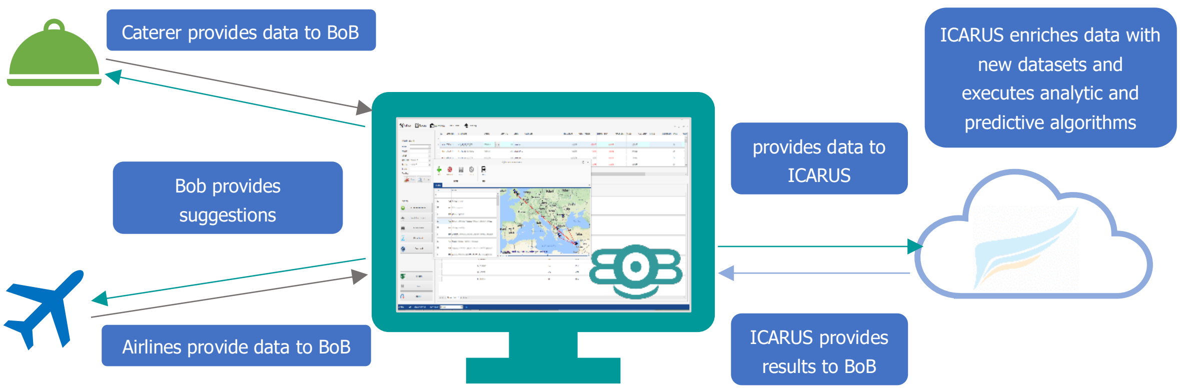

Figure 6-9: CELLOCK Demonstrator Scenario 2 Interactions with Aviation Stakeholders

6.3.4 Business Processes: AS-IS and TO-BE

The scenario will introduce a new, niche feature in Cellock's BoB system analytics, providing suggestions to its end-users (caterers and airlines) regarding the discounts and bundle product offers of FnB and Duty-free items that will be available on board. Currently, BoB contains Business Intelligence for the available products (inventory, sales per flight, missing/damaged products and money) and it is expected that with the implementation of the scenario, suggestions will be provided in short-term and long-term, e.g. for the following days, weeks or months. This is a novel feature, that differentiates BoB from the competition, showcasing an important parameter to airlines, when it comes to marketing promotions regarding in-flight sales.

Table 6-12: CELLOCK Scenario 2 Business Processes

<table>
<tr><th>Scenario</th><th colspan="2">Predict profitable product discounts and offers to increase inflight sales.</th></tr>
<tr><td>Business Process</td><td colspan="2">Suggestions on FnB and Duty-free discounts</td></tr>
<tr><td colspan="2">AS-IS Situation (Before ICARUS)</td><td>TO-BE Situation (With ICARUS)</td></tr>
<tr><td colspan="2">Duty-free products usually have no discounts and are sold on Recommended Retail Price (RRP)

Selected FnB bundle items are offered with a discount

Discounts are fleet-based and do not estimate seasonality, weather conditions and trip details (departure, destination)</td><td>Upload BoB data to ICARUS

Link with ICARUS relevant datasets

Run descriptive and predictive analytics on current and historic data

Suggest discounts and offers, considering seasonality, weather conditions and trip details.

Display suggestions</td></tr>
<tr><td>Critical ICARUS Features</td><td colspan="2">(Reference to critical ICARUS Requirements from D3.1 and MVP features from D1.2)
PLATF_F_02 Uploading of data assets as files extracted by the aviation stakeholder's back-end system
PLATF_F_18 Searchability and identification of related additional data assets
PLATF_F_22 Definition of simple and advanced information queries
PLATF_F_28 Navigation to preconfigured analytics
PLATF_F_29 Definition of an analytic task that runs an individual algorithm
PLATF_F_30 Definition of a workflow of analytic tasks that combine algorithms
PLATF_F_35 Execution of an analytics task / algorithm according to specific preferences and settings for computation resources
PLATF_F_38 Visualization of the analytics results to gain insights on the data and / or comparison how the same results are visualized in different diagrams
PLATF_F_39 Definition of customized dashboards by selecting which visualizations should appear
PLATF_F_42 Export of analytics reports as a downloadable file
PLATF_F_51 Proposition of additional data assets for the enrichment of existing data assets and / or for analysis and visualisation
PLATF_F_57 Negotiation of a data sharing agreement</td></tr>
</table>

6.3.5 Test Cases

The aim of the tests is to verify the operability of the scenario and to validate the targeted business objectives.

In the specific scenario the tests are:

1. Upload BoB data to ICARUS
2. Browse ICARUS for relevant datasets
3. Link with other relevant data
4. Browse ICARUS for available analytics and applications
5. Design and apply the ICARUS descriptive and predictive analytics
6. Visualize results

Table 6-13: CELLOCK Scenario 2 Test Case 1

Test Case	Upload BoB data to ICARUS
Actors	CELLOCK as ICARUS user, ICARUS Platform
Importance	High
Pre-conditions	BoB data available on the On-Premise Environment. Authorization to login to the ICARUS platform
Post-conditions	BoB data are encrypted and stored in ICARUS private user workspace
Workflow	7. Login to ICARUS platform 8. Select option to add dataset as a csv format file 9. Define the data preparation steps in the ICARUS platform 10. Encrypt BoB data in the On-Premise Environment following the data preparation steps provided by the ICARUS platform 11. Upload BoB data to the ICARUS platform *1.* Define data access policies, data confidentiality and data license details
Related ICARUS Phase	Data Collection, Asset Storage
Success Indication	Upload process is completed with a message
Failure Indication	Upload process aborts with a warning message
Notes	-

Table 6-14: CELLOCK Scenario 2 Test Case 2

Test Case	Browse ICARUS for other relevant datasets
Actors	CELLOCK as ICARUS user, ICARUS Platform
Importance	Medium
Pre-conditions	Dataset availability in the ICARUS platform

Post-conditions	Select or purchase and view Datasets from other providers
Workflow	1. Login to ICARUS platform and go to the Marketplace page 2. Define data query by keywords, format, data type, etc 3. Run the query 4. Browse the results 5. Preview public datasets and samples of private datasets 6. Select/purchase the datasets of interest 7. Use the new datasets on ICARUS or download them.
Related ICARUS Phase	• Data Exploration • Data Asset Sharing
Success Indication	Purchase process completes with a message
Failure Indication	Purchase process aborts with a warning
Notes	

Table 6-15: CELLOCK Scenario 2 Test Case 3

Test Case	**Link BoB data to other relevant data on ICARUS**
Actors	CELLOCK as ICARUS user, ICARUS Platform, dataset provider
Importance	Medium
Pre-conditions	• User logged in to the ICARUS platform • Cellock data stored in the ICARUS secure and private data space • Relevant datasets available in ICARUS
Post-conditions	Relevant linked datasets stored in the ICARUS secure and private data space for CELLOCK
Workflow	1. Browse through already acquired datasets in ICARUS. 2. Select one or multiple datasets 3. Create links between BoB's dataset and related datasets in the ICARUS secure and private data space
Related ICARUS Phase	• Data Exploration • Asset Storage • Data Enrichment
Success Indication	Linking process completes with a message
Failure Indication	Linking process aborts with a warning message

Table 6-16: CELLOCK Scenario 2 Test Case 4

Test Case	**Browse ICARUS for available applications**
Actors	CELLOCK as ICARUS user, ICARUS Platform
Importance	Medium

Pre-conditions	User logged in to the ICARUS platform BoB data stored in the ICARUS platform and available in the ICARUS private and secure space of CELLOCK Relevant datasets available in ICARUS
Post-conditions	Available applications are displayed
Workflow	1. Login to ICARUS platform and go to the Marketplace 2. Search for applications that use analytical algorithms related to BoB datasets, by keyword, used data or type 3. Browse results 4. Select/purchase the applications of interest
Related ICARUS Phase	• Data Analytics • Added Value Services
Success Indication	Search process completes without message
Failure Indication	Search process aborts with a warning message
Notes	

Table 6-17: CELLOCK Scenario 2 Test Case 5

Test Case	**Design and apply the ICARUS descriptive and predictive analytics**
Actors	CELLOCK as ICARUS user, ICARUS Platform
Importance	High
Pre-conditions	User logged in to the ICARUS platform Data available in the ICARUS secure and private workspace for CELLOCK Analytics algorithm(s) available in the ICARUS platform (have already been purchased or selected)
Post-conditions	Analytics results available in ICARUS secure data space
Workflow	1. Login to the ICARUS platform and go to the workspace 2. Select analytics algorithms 3. Select BoB datasets and any other relevant dataset 4. Design the analytics workflow and adjust algorithm options and settings (if needed) 5. Run the analytics workflow 6. Review/save results
Related ICARUS Phase	*From the methodology in D1.2* • Data Analytics • Added Value Services
Success Indication	Workflow completes without message
Failure Indication	Analytic workflow aborts with a warning message

Table 6-18: CELLOCK Scenario 2 Test Case 6

Test Case	**Visualize results**
Actors	CELLOCK as ICARUS user, ICARUS Platform
Importance	High
Pre-conditions	User logged in to the ICARUS platform BoB data available in the ICARUS secure and private workspace for CELLOCK Analytics workflows designed in the ICARUS platform
Post-conditions	Sales prediction visualizations available in ICARUS
Workflow	1. Login to the ICARUS platform 2. Search for available visualizations 3. Select the related analytics workflow that should be visualized 4. Customize chart/visualization options if needed 5. Display the chart/visualization results
Related ICARUS Phase	• Data Analytics • Added Value Services
Success Indication	Visualization is displayed without a message
Failure Indication	Visualization aborts with a warning message
Notes	-

6.3.6 Data Availability and Needs

The execution of the scenario requires datasets that are available to CELLOCK, through its BoB system, as well as from 3rd parties, through the ICARUS platform, as summarized in the table below. These datasets contain retail and F&B data (sales and discrepancies) as well as the total number of passengers per flight. Datasets with High criticality are vital for the scenario, while the Medium ones will provide useful insights but are not considered absolutely necessary. The Low criticality data do not affect the scenario execution but will improve the overall outcome.

Table 6-19: CELLOCK Scenario 2 Data Available Overview

ID	Data Asset Title	Data Provider	Criticality
CELLOCK_01	Retail and F&B in-flight sales	CELLOCK	High
CELLOCK_02	Number of Passengers	CELLOCK	Medium
CELLOCK_07	Flights Discrepancies	CELLOCK	High

Table 6-20: CELLOCK Scenario 2 Data Needed Overview

ID	Data Asset Title	Data Provider	Criticality	Status
CELLOCK_DR_01	Weather data	OAG	Low	To be available in the ICARUS platform
CELLOCK_DR_05	Flight Delays	OAG	Medium	Available on ICARUS
CELLOCK_DR_07	Country demographic statistics (e.g. GDP, population, etc.)	Open Data	Medium	Under investigation

More detailed information about the data available and needed is provided in the ICARUS Deliverable D1.1 "Domain Landscape Review and Data Value Chain Definition" and shall be updated in the forthcoming Deliverable D1.3 "Updated ICARUS Methodology and MVP WP1".

6.4 Considerations, Constraints and Preconditions

For both scenarios, the aim is to provide airlines and caterers with suggestions, therefore it is important to be able to frequently update the datasets (which are already available on BoB by CELLOCK). CELLOCK is going to upload to the ICARUS platform the up-to-date data and retrieve the results whenever it is needed, since the airlines and caterers are already connected with BoB in real-time. It is also important that the platform operates uninterruptedly and without delays, as expected by a cloud service. External data that are needed for both the scenarios, such as weather data, need also to be updated frequently.

6.5 Business Impact and Expected Benefits

The implementation of these scenarios will improve CELLOCK's current software solution (BoB), will expand the product range and add value to the services offered to airlines and caterers, enhancing the brand and adopting novel technology trends in the company's product portfolio. For CELLOCK, these new features, when integrated to the currently offered system, will provide the cutting-edge functionality that our clients seek. Finally, ICARUS will also benefit and increase the CELLOCK product sales, creating a new source of revenue for the company and subsequently ICARUS.

In addition, both scenarios aim to improve daily operations for both airlines and caterers by:

- Increasing sales and profits, offering more targeted products on board (Both scenarios)
- Reducing waste of products and consequently cutting costs (1st scenario)

The following table presents the key performance indicators that are associated with the CELLOCK scenarios.

Table 6-21: CELLOCK Key Performance Indicators

Scenario	KPI	Calculation Method	AS-IS Value	TO-BE Value	Verification Means
1	Increased accuracy of predictions for sales on board and tray loading	[[Predicted sales on board and tray loading created with the help of ICARUS] – [Current sales on board and tray loading]] / [Current sales on board and tray loading]	-	15%	Comparisons of actual data already available from BoB with the ICARUS calculations
1	Increased prediction accuracy for reducing food waste weight	[[Predicted food sales created with the help of ICARUS] – [Food sales anticipated with the current business practices]] / [Food sales anticipated with the current business practices]	-	15%	Comparisons of actual data already available from BoB with the ICARUS calculations
2	Increased number of suggested discounts and offers to select	[[Number of suggested offers with ICARUS] - [Number of suggested offers based on current business practices]] / [Number of suggested offers based on current business practices]	-	25%	Comparisons of actual data already available from BoB with the ICARUS calculations
1, 2	Increased customer satisfaction for BoB	[[Customer satisfaction upon embedding results from ICARUS] – [Current customer satisfaction for BoB]] / [Current customer satisfaction for BoB]	-	15%	Interviews, questionnaires
1, 2	Expected increase in the BoB licenses	[[Forecasted licenses turnover with the ICARUS add-ons] – [Current licenses turnover]] / [Current licenses turnover]	-	10%	Financial projections of selling additional licenses to existing user base or to new customers

6.6 Demonstrator Execution Plan

The execution plan for both scenarios is summarized below. According to the plan, during the preparation and early stages both scenarios will be targeted.

- In the early demonstrator stages (M15-M24), the CELLOCK demonstrator will focus on the concept evaluation and on detailed specifications for the scenarios (I.1), examine data sources and availability in ICARUS (I.2) and experiment on analytics (I.3). CELLOCK will also work on internal BoB developments to support exposing data to ICARUS (I.4) and on verification of the analytics results' retrieval from the ICARUS platform (I.5).
- In the intermediate demonstrator stages (M24-M30), the focus will be on finalizing the 1st scenario (I.6), repeating steps I.2 and I.3 and stabilizing it for final release (I.7).

- At the final demonstrator stage (M30-M36), the CELLOCK demonstrator will work on collecting data and performing analytics for the 2nd scenario in the ICARUS platform (I.8) and stabilizing it for release (I.9). Finally, the lessons learnt will be examined and the business case scenarios will be evaluated (I.10).

Table 6-22: Demonstration Activities for CELLOCK

Demonstration Activities	M15	M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30	M31	M32	M33	M34	M35	M36
I.1																						
I.2																						
I.3																						
I.4																						
I.5																						
I.6																						
I.7																						
I.8																						
I.9																						
I.10																						

7 Conclusions & Next Steps

This deliverable aimed to prepare and coordinate the demonstrator activities by detailing the set of scenarios in the different 1st-2nd-3rd data value chain stakeholders represented in ICARUS. Through dedicated brainstorming sessions by the demonstrators and their IT support partners, as well as during the ICARUS plenary meetings, the demonstrator scenarios were shaped up taking into account the critical data availability challenge (within the ICARUS consortium and beyond) in order to ensure their feasibility within the project duration.

Overall, during the demonstrators baseline activities, operation planning and coordination under task T5.2: (a) the business context of the demonstrators was revisited, (b) the demonstrator scenarios (that were originally defined in the ICARUS DoA) were significantly revised and repurposed, (c) the current considerations and constraints in the demonstration activities were identified, (d) the anticipated business impact was elaborated and quantified in concrete Key Performance Indicators (KPIs), and (e) the detailed execution plan per demonstrator was described taking into account the overall guidelines provided in the demonstrators high-level plan.

Each demonstrator scenario has been described in detail from a demand-driven perspective, considering the current challenges that the business partners currently face. The business objectives within ICARUS were set and the expected interactions with other aviation stakeholders were mapped while the as-is processes were described and compared to the expected to-be situation with the ICARUS platform. Specific test cases on how each demonstrator plans to technically validate the ICARUS platform are defined and required significant exchange of know-how and expectations with the technical partners in order to reach a common understanding. Finally, the data availability and needs exercise (that started in WP1) was also summarized under each scenario to showcase that the data are the driving force behind each and every demonstrator.

As the ICARUS demonstrators have been positioned vis-à-vis the ICARUS methodology phases and the MVP, it easily becomes evident that they are complementary and collectively leverage all the expected functionalities to be delivered in the ICARUS platform.

The next steps related to this deliverable are the preparation of the necessary documentation regarding the ICARUS platform (as soon as the beta release of the ICARUS platform is ready), and the continuous monitoring and coordination of the execution of the demonstrators until the end of the project. The outcomes of such activities will be reported in detail in D5.3 (Demonstrators Operation Evaluation and Feedback–v1.00), D5.4 (Demonstrators Operation Evaluation and Feedback–v1.50) and D5.5 (Demonstrators Operation Evaluation and Feedback–v2.00).

Annex I: References

ICARUS (2018a) D1.1 "Domain Landscape Review and Data Value Chain Definition"

ICARUS (2018b) D1.2 "The ICARUS Methodology and MVP"

ICARUS (2019a) D2.1 "Data Management and Value Enrichment Methods"

ICARUS (2019b) D2.2 "Intuitive Analytics Algorithms and Data Policy Framework"

ICARUS (2019c) D3.1 "ICARUS Architecture, APIs Specifications and Technical and User Requirements"

ICARUS (2019d) D5.1 "ICARUS Demonstrators and Platform Evaluation Framework"

SITA (2018) Air Transport IT Insights 2018. Retrieved on March 21st, 2019 from https://www.sita.aero/resources/type/surveys-reports/air-transport-it-insights-2018