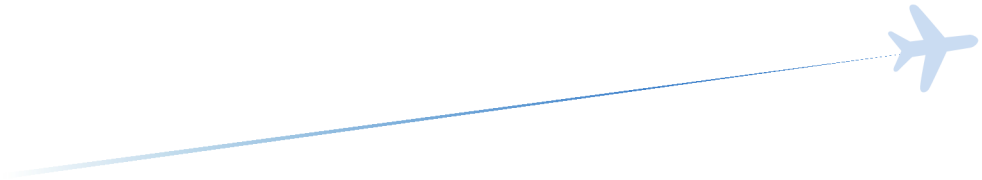

Project Management Plan

Deliverable 1.1

TBO-Met

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Topic:	**Sesar-04-2015 - Environment and Meteorology in ATM**
Consortium coordinator:	**University of Seville**
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TBO-Met

METEOROLOGICAL UNCERTAINTY MANAGEMENT FOR TRAJECTORY BASED OPERATIONS

This project has received funding from the SESAR Joint Undertaking under grant agreement No 699294 under European Union's Horizon 2020 research and innovation programme.

Project Management Plan

Abstract

TBO-Met is a project aligned with the research topic "Environment & Meteorology for ATM", which is part of the research area "ATM Excellent Science & Outreach" of the SESAR 2020 Exploratory Research programme (call H2020-SESAR-2015-1). The context of the project is the development of methodologies to manage meteorological uncertainty suitable to be integrated into the ATM system. TBO-Met focuses on two problems: trajectory planning and prediction of sector demand, both at pre-tactical and tactical levels, and it has the following two main objectives: 1) to improve the predictability of aircraft trajectories subject to meteorological uncertainty, keeping acceptable levels of efficiency (trade-off between predictability and efficiency), and 2) to increase the accuracy of the prediction of sector demand when meteorological uncertainty is taken into account.

The Project Management Plan (PMP) of the project TBO-Met presented in this document is intended to guide the execution and control of the project. The PMP provides a complete description of the organisation and the management of the project. In particular it describes roles and responsibilities, administration and coordination activities, risks and issues management. The communication, dissemination, and exploitation plans are also described in the PMP: the communication elements and the dissemination activities are detailed, and the process to make public and/or to protect the project results is defined. Also, since one of the activities of the project is to conduct a survey among the stakeholders, the implementation of the corresponding ethical requirements is described in this plan. The PMP is primarily intended for the SESAR Joint Undertaking and the consortium members participating in the project, since it forms the baseline for the monitoring of the project progress.

Table of Contents

1 Executive Summary

The Project Management Plan (PMP) of the project TBO-Met is presented in this document. This plan is intended to guide the execution and control of the project. Its target audience is the SESAR Joint Undertaking and the consortium members: Agencia Estatal de Meteorología (Spain), MeteoSolutions GmbH (Germany), University of Salzburg (Austria), University Carlos III of Madrid (Spain), and University of Seville (Spain, consortium coordinator).

TBO-Met addresses the topic Sesar-04-2015 - Environment and Meteorology in ATM, of the call H2020-SESAR-2015-1; in particular Meteorology. The overall objective of the project is threefold: 1) to advance in the understanding of the effects of meteorological uncertainty in TBO; 2) to develop methodologies to quantify and reduce the effects of meteorological uncertainty in TBO; and 3) to pave the road for a future integration of the management of meteorological uncertainty into the air traffic management system.

The PMP provides a complete description of the organisation and the management of the project. In particular:

- the different roles and their tasks and responsibilities are described, and these roles are allocated to named individuals;
- the management activities are described and classified into administration and coordination activities;
- a Gantt chart illustrating the schedule of the project is provided; and
- the risk and issues management plan is presented, along with a list of the identified risks for this project.

The communication, dissemination, and exploitation plans are also described in the PMP. In particular, the communication elements (e.g., communication objectives, high level messages…) and the communication activities (e.g., participation at SESAR Innovation Days, publication of scientific papers…) are detailed. The dissemination and exploitation plans describe the process to make public and/or to protect the project results.

Finally, since one of the activities of the project is to conduct a survey among the stakeholders, ethical requirements arise. The implementation of these requirements, related to dealing with human participants and personal data, is also described in this plan.

2 Introduction[1]

In this document, the Project Management Plan (PMP) of the project entitled 'Meteorological Uncertainty Management for Trajectory Based Operations — TBO-Met' is presented. This plan elaborates further the project information provided in the Grant Agreement (as required in the Project Execution Guidelines [1]); in particular, it details the Communication and Dissemination Plans and addresses the Ethics Requirements. The Grant Agreement will remain the contractual reference. In the event of a conflict between the PMP and the Grant Agreement, the Grant Agreement takes precedence.

The PMP is primarily intended for the SESAR Joint Undertaking and the consortium members participating in the project (AEMET, MetSol, PLUS, UC3M, USE), since it will form the baseline for the monitoring of the project progress.

This document is organized as follows. The organisation of the project, with role allocations to named individuals, is shown in Section 3. In Section 4, the project schedule is included in the form of a Gantt chart, which is expected to be used to track progress throughout the execution of the action and as baseline for possible changes. This chart is also provided as a separate MS-Project file.

The management plan *sensu stricto*, divided into administration and coordination activities, and the management procedures to be followed in the project, is shown in Section 5. In Section 6, the risk and issues management plan is presented. The communication, and dissemination and exploitation plans are detailed in Sections 7 and 8, respectively. Finally, the implementation of the ethics requirements applying to this project, is tackled in Section 9.

Next in this section, with the aim of helping in the understanding of the management plan, the context of the project in terms of research topic and objectives of SESAR 2020, a summary of the actions to be carried out in the project, and the work plan structure are given. Following, the main changes with respect to the Grant Agreement are summarized. A list of acronyms is also given at the end of this section.

[1] The opinions expressed herein reflect the author's view only. Under no circumstances shall the SESAR Joint Undertaking be responsible for any use that may be made of the information contained herein.

2.1 Project Context

The TBO-Met project corresponds to the research topic "Environment & Meteorology for ATM", which is part of the research area "ATM Excellent Science & Outreach" of the SESAR 2020 Exploratory Research programme (call H2020-SESAR-2015-1).

This project is fully aligned with the objectives of the SESAR 2020 Exploratory Research programme, in particular the following ones related to the "Meteorology" topic: "to enhance meteorological capabilities and their integration into ATM planning processes for improving ATM efficiency" and "to develop 4D trajectories that are optimised to take account of all environmental considerations", and where the following impact is expected: "to enhance ATM efficiency by integrating meteorological information".

In this context, the overall objective of the project is threefold:

1) To advance in the understanding of the effects of meteorological uncertainty in TBO.
2) To develop methodologies to quantify and reduce the effects of meteorological uncertainty in TBO.
3) To pave the road for a future integration of the management of meteorological uncertainty into the air traffic management system.

2.2 Project Summary

This section contains a summary of the TBO-Met Project. The aim is to include a description of the project scope, described in detail in the Grant Agreement [2].

Project Objectives

In 2005 the European Commission set high-level goals for the Single European Sky (SES) to be met by 2020 and beyond. To accomplish these goals it is required a paradigm shift in operations through state-of-the-art, innovative technology and research. As we know, SESAR (Single European Sky ATM Research) is the technological component of the SES initiative, which has the overall objective of creating such a paradigm shift.

In the future ATM system the 4D trajectory becomes the fundamental element of a new set of operating procedures: **Trajectory-Based Operations** (TBO). The TBO concept is a new way to plan the air traffic and to increase the capacity and efficiency of the system while preserving or augmenting the safety, evolving from the current airspace-based ATM system to a trajectory-based system designed to accommodate airspace users' requests to the maximum extent possible (SESAR Consortium, 2007). The Business Trajectory constitutes a fundamental element of the TBO concept, which is the 4D trajectory that will best meet airline business interests, and evolves out of a collaborative layered planning process.

One key factor that affects those high-level goals set for SES is uncertainty. Uncertainty is an inherent property of real-world socio-technical complex systems, like ATM. **If the capacity of the system is to be increased while maintaining high safety standards and improving the overall performance, uncertainty levels in ATM have to be reduced and new strategies to deal with the remaining uncertainty must be found.** And to do that, it is necessary to understand uncertainty.

Weather uncertainty has been identified to be one of the main sources of uncertainty that affect the ATM system (as can be found in [3]). In this project we focus on the analysis of meteorological uncertainty coming from the wind and form the convective regions, including individual storm cells. The importance of these two types of uncertainty has been assessed in the literature: in Granger et al. (2001) the speed uncertainties due to wind prediction errors are identified as the most important factor affecting the en-route trajectory predictions and thus the robustness of the pre-synchronized traffic scenarios; and, according to Zelinski and Jastrzebski [4], convective weather is currently identified as one of the ATM uncertainty factors that most seriously affect the network route structure, and thus the optimal flight trajectory planning. Weather predictions will be based on Ensemble Probabilistic Forecasts and Nowcasts.

In this project the problem of analysing and quantifying the effects of meteorological uncertainty in Trajectory Based Operations is addressed. In particular, two problems are considered: **trajectory planning** and **sector demand analysis**, which correspond to two different scales: trajectory (micro) scale and sector (meso) scale.

At the trajectory scale, the main objective is **to assess and improve the predictability of efficient 4D trajectories when weather uncertainty is taken into account**, both at the pre-tactical level (up to three hours before departure) and at the tactical level (during the flight). To reach this goal, a methodology based on the use of stochastic trajectory optimization will be used.

At the sector scale, the main objective **is to analyse the impact of trajectory planning under weather uncertainty (as performed at the trajectory scale) on sector demand**. To achieve this objective, a methodology will be developed to measure the uncertainty of sector demand (probabilistic sector loading), based on the uncertainty of the individual trajectories. This analysis will also provide an understanding of how weather uncertainty is propagated from the trajectory scale to the sector scale.

Project approach and methodology

Stakeholders survey

To help in achieving the project objectives, a survey among the stakeholders involved (airlines, ANSPs and Network Manager) is to be performed. The main result of the survey will be a first-hand expert description of current practice and future expectations. It will serve as a valuable reference to align the project activities.

Ensemble forecasts and nowcasts

In this project, both wind and convection will be modelled using a probabilistic approach (deterministic weather forecasts are significantly less accurate). The uncertainty of the wind field and of the convective region will be derived from Ensemble Prediction Systems (EPS); and the uncertainty of individual cells within the convective region will be derived from nowcast systems.

Ensemble forecasting is a prediction technique that generates a representative sample of the possible future states of the atmosphere. An ensemble forecast is a collection of typically 10 to 50 weather forecasts (referred to as members) with a common valid time, which can be obtained using different Numerical Weather Prediction (NWP) models based on time-lagged, multi-model, and/or multi-initial conditions approaches. Aviation applications demand high-resolution, short-range/very short range meso- and storm-scale ensemble weather forecasting. Recently, short range ensemble forecasting systems have been designed to estimate uncertainty. The UK Met Office (Bowler et al. [5]), the Spanish Met Service (AEMET-SREPS: Garcia-Moya et al. [6]), and Météo-France (Prévision d'Ensemble ARPEGE: Descamps et al. [7]) among others, have developed such systems.

Nowcast models have been developed for shorter forecast times. They start from a given state of the atmosphere, e.g. a storm field and extrapolate the movement and the temporal development of the latter. Nowcast systems work on the regional scale and are quite reliable for one hour lead time with decreasing accuracy for longer times. Nowcast models usually use radar or satellite data, some in combination with wind data, and either process the complete image (as done in the SWIRLS nowcast model of Hong Kong Observatory, Li et al. [8]) or extract relevant structures. Object based nowcast models like Rad-TRAM and Cb-TRAM from WxFusion are based on radar and satellite data (Kober and Tafferner [9]), respectively, and also allow for nowcasting the individual cell development which is based on a pyramidal image matching process (Kober [10]). The GANDOLF model is another advanced nowcast system developed by UK Met Office (Hand [11]). Nowcast systems cannot generate new weather features such as a new storm, they rather have to rely on existing ones.

Quantifying meteorological uncertainty

An important issue is the calculation of appropriate measures of uncertainty.

For wind field and convective regions, the spread of solutions in time and space can be used as a measure of uncertainty; therefore, the spread has to be defined and calculated following a methodology yet to be developed.

For individual thunderstorm cells, nowcast models will be used (DeLaura and Evans [12]); therefore a different approach has to be considered to obtain a measure for the inherent uncertainty and the uncertainty related to the models. Here we follow the line of thoughts of the PhD thesis of Manuela Sauer (see Sauer et al. [13]) and determine the uncertainty of the nowcast of individual cells as the difference between the nowcast of a cell and the observation of the same cell at the same time in terms of position, spatial extent and strength (the latter is not investigated by Manuela Sauer).

Trajectory planning at pre-tactical and tactical level under meteorological uncertainties

TBO-Met project addresses the problem of finding trajectory planning algorithms that consider the trade-offs between efficiency and predictability of 4D trajectories under meteorological uncertainties.

At pre-tactical level, methodologies to quantify trade-offs between efficiency and predictability of 4D trajectories considering meteorological uncertainties (wind and convective regions) have to be developed. Stochastic trajectory optimization algorithms will be used to find the relation between efficiency and predictability and the most suitable trajectories as a trade-off. Methods based on Monte Carlo (MC) (Hastings [14]) (a natural choice due to its ease of implementation, however

computationally very intense) and Generalized Polynomial Chaos (GPC) (Prabhakar et al. [15]) (conceptually much more involved, however with better computationally performance for problems with limited number of variables) will also be explored.

At tactical level, methodologies to quantify trade-offs between efficiency and predictability of 4D trajectories will be developed, considering the meteorological uncertainty of individual thunderstorm cells. Nowcasts will be used to model individual thunderstorm cells and their uncertainty. Several storm avoidance tactics will be investigated, such as early thunderstorm avoidance, “wait and see”, and complete ignorance up to the last moment. For each tactic, a Monte Carlo method will be applied to determine the frequency of encounters and the deviation length as functions of the parameters that define the tactics.

Prediction of sector demand

One of the main problems at the traffic scale is the problem of flow management. Traditionally, this problem was based primarily on a comparison of deterministic demand and capacity predictions at elements such as airports and en-route sectors, ignoring the stochastic nature of the predictions. However, in the recent years, several efforts have been made under SESAR and NextGen programs to take into account uncertainty in predictions and moving from deterministic to probabilistic flow management (see, for example, Ramamoorthy et al. [16], Grabbe et al. [17] and Taylor and Wanke [18]).

TBO-Met project addresses the uncertainty in the execution of the finally planned demand, i.e. the uncertainty in how the aircraft trajectory varies between what is expected on the basis of the flight plan and what is finally flown. In particular, the prediction of demand will be obtained by means of the statistical processing of the uncertainty of individual flights, not by using aggregated flow models. The developed method will take into account the possibility that traffic placed into a sector could be deviated to adjacent sectors, as can happen, for example, when avoiding large convective zones. This possibility is not considered by the current methods (see Meyn [19], Gilbo and Smith [20], and Gilbo and Smith [21]).

The uncertainty of the demand will be examined when trajectories obtained with the methods developed in the project are considered. This analysis will allow to assess how the sector demand is affected by the trade-offs between efficiency and predictability considered at the trajectory scale.

Simulations

All the solutions proposed in this project will be evaluated and assessed using an advanced air traffic simulator. The advanced NAVSIM/USBGSim environment of University of Salzburg will be adapted to simulate and evaluate the TBO-Met scenarios and to demonstrate the benefits of the proposed concepts and solutions.

2.3 Work Plan

The work plan is broken down into 8 work packages (WPs), as sketched in Figure 2.1. The objectives of each WP are the following:

- WP1 Project management

  To effectively fulfil all the administrative, contractual, financial and technical aspects of the coordination of the project.

- WP2 Data provision and data processing

  To provide and process of all data and meteorological information needed in the project.

- WP3 Survey among stakeholders

  To elaborate a survey among all stakeholders involved, so that the project is aligned with their current practice and future expectations regarding meteorological uncertainty management and all the relevant issues are taken into account.

- WP4 Trajectory planning under meteorological uncertainty

  To analyse trade-offs between efficiency and predictability of 4D trajectories under meteorological uncertainty within the envisioned TBO operational concept.

- WP5 Sector demand analysis under meteorological uncertainty

  To increase the accuracy of the prediction of sector demand when meteorological uncertainty is taken into account.

- WP6 Evaluation and assessment of solutions

  To evaluate and assess both the proposed trajectory planning concept under meteorological uncertainty and the resulting sector load aspects.

- WP7 Dissemination, exploitation and communication

  To coordinate all TBO-Met dissemination, exploitation, and communication activities while ensuring that the different targets have been reached.

- WP8 Ethics requirements

  To ensure compliance with the ethics requirements set out in this work package.

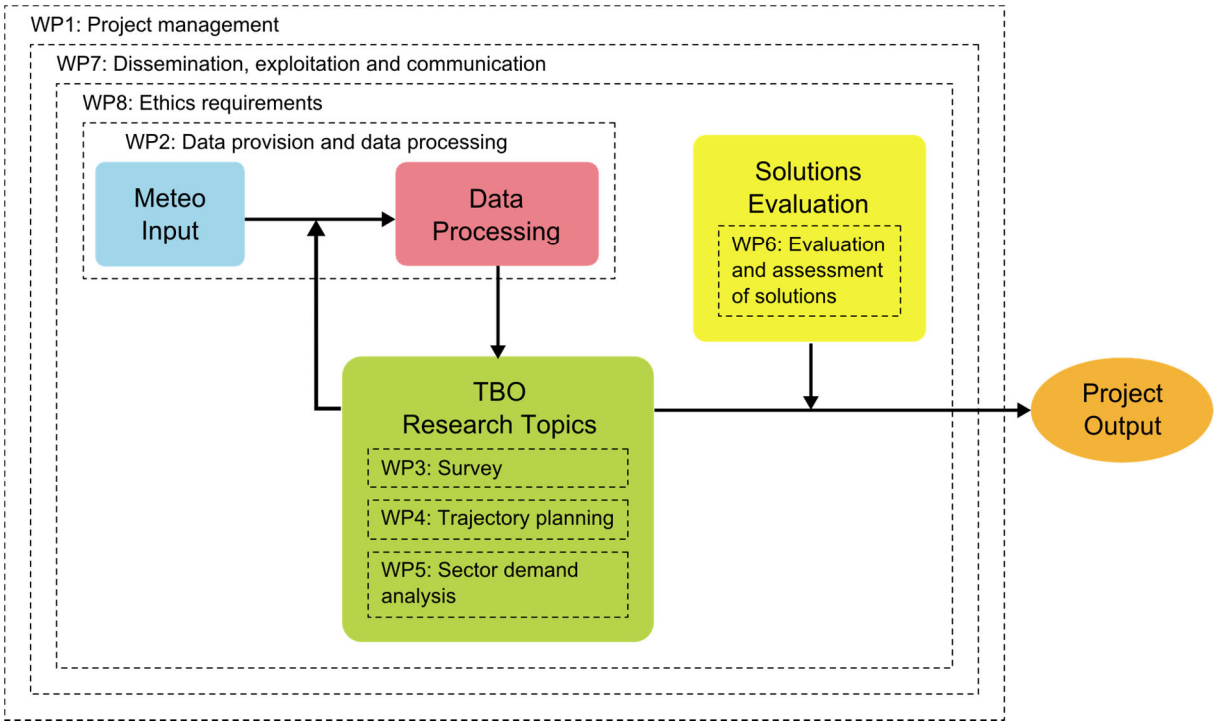

Figure 2.1. Work plan breakdown

2.4 Changes with respect to the Grant Agreement

The main changes of the Project Management Plan with respect to the Grant Agreement [2] are the following:

- Representative individuals from the stakeholders will be invited to participate in the SB meetings. The named individuals are given in Section 3.2.
- As agreed in the Kick-Off Meeting [22], the SB meeting 1 will take place in Madrid instead of Valencia (see Section 4).
- The Gantt chart has been modified: dates are updated and milestones are included (see Section 4).
- The management plan and the procedures are described in more detail (see Section 5).
- The risks and issues management is described in more detail (see Section 6).
- Two new risks have been identified (R11 and R12). Also, risks R7, R8, R9, and R10 have been renumbered (see Section 6.2).
- The communication elements and activities are described in more detail (see Section 7).
- The dissemination and exploitation plans are described in more detail (see Section 8).

- The implementation of the ethics requirements derived from the interviews foreseen in WP3 (Survey among stakeholders) is described in more detail.

2.5 Acronyms and Terminology

Term	Definition
ANSP	Air Navigation Service Provider
ATM	Air Traffic Management
IPR	Intellectual Property Rights
JU	Joint Undertaking
MET	Meteorology
PC	Project Coordinator
PMP	Project Management Plan
SB	Steering Board
SESAR	Single European Sky ATM Research Programme
SJU	SESAR Joint Undertaking
TBO	Trajectory-Based Operations
WP	Work Package

TBO-Met Consortium

AEMET	Agencia Estatal de Meteorología
MetSol	MeteoSolutions GmbH
PLUS	University of Salzburg
UC3M	University Carlos III of Madrid
USE	University of Seville

3 Organisation

In this section, the organisation of the project is presented. In particular, the named individuals that lead the work packages and the tasks, and those who participate in the management of the project are identified.

3.1 Work Plan Structure

The project is divided into 8 work packages and they are subdivided into tasks. The results of the work carried out in the WPs are provided as deliverables and the significant events on the completion of the work are marked by milestones.

Each WP is led by a WP Leader (WPL), and each task is led by a Task Leader. WPLs manage and monitor the progress of the tasks of their WPs through a continuous dialogue with the Task Leaders. Each WPL is responsible for:

- Coordinating the work of his WP.
- The scientific/technical progress of the activities in his WP.
- The planning, monitoring and reporting (periodical reports and deliverables) of each task in his WP.
- Collecting and submitting the required scientific, technical, financial and administrative data.

Each Task Leader is responsible for

- The timely implementation of the activities in the task and the reporting to the WP Leader.
- Taking, in agreement with the concerned WP Leader, decisions at the task level.

The Work Package and Task Leaders are listed in Table 3.1. The WP Leaders have been chosen on the basis of their specific expertise and their experience of team work at international level. The deliverables and milestones along with their due date are listed in Tables 3.2 and 3.3, respectively.

Table 3.1. Work Package and Task Leaders

WP or task number	WP or Task Leader	Partner
WP 1. Project management	Prof. Damián Rivas	USE
Task 1.1. Project administration	Prof. Damián Rivas	USE
Task 1.2. Project coordination	Prof. Damián Rivas	USE
WP 2. Data Provision and Processing	Mr. Jürgen Lang	MetSol
Task 2.1. Requirements and concept for EPS processing	Mr. Daniel Sacher	MetSol
Task 2.2. Software development for EPS data	Mr. Daniel Sacher	MetSol
Task 2.3. Requirements and concept for nowcast processing	Mr. Daniel Sacher	MetSol
Task 2.4. Software development for nowcast data	Mr. Daniel Sacher	MetSol
WP 3. Survey among stakeholders	Dr. Manuel Soler	UC3M
Task 3.1. Preparation of the survey to be conducted	Dr. Manuel Soler	UC3M
Task 3.2. Realization of the interviews and processing of the results	Dr. Manuel Soler	UC3M
WP 4. Trajectory planning	Dr. Manuel Soler	UC3M
Task 4.1. Development of methodologies to quantify the trade-off between efficiency and predictability of 4D trajectories at pre-tactical level considering meteorological uncertainty	Dr. Manuel Soler	UC3M
Task 4.2. Development of methodologies to quantify the trade-off between efficiency and predictability of 4D trajectories at tactical level considering the uncertainty of individual thunderstorm cells	Mr. Daniel Sacher	MetSol
Task 4.3. Definition of simulations to evaluate the proposed solutions for trajectory planning	Dr. Manuel Soler	UC3M
WP 5. Sector demand analysis	Prof. Damián Rivas	USE
Task 5.1. Development of a methodology to measure the uncertainty of sector demand due to weather uncertainty	Dr. Alfonso Valenzuela	USE
Task 5.2. Analysis of the effects of weather uncertainty on sector demand	Dr. Alfonso Valenzuela	USE
Task 5.3. Definition of simulations to evaluate the proposed solutions for sector demand analysis	Dr. Alfonso Valenzuela	USE
WP 6. Evaluation and assessment of solutions	Prof. Carl-Herbert Rokitansky	PLUS
Task 6.1. Adaptation of PLUS's ATM/ATC/CNS simulation environment for evaluation of the new 4D-trajectory planning under meteorological uncertainty	Prof. Carl-Herbert Rokitansky	PLUS

Task 6.2. Simulation, evaluation and assessment of 4D-trajectory planning under meteorological uncertainty	Prof. Carl-Herbert Rokitansky	PLUS
Task 6.3. Simulation, evaluation and assessment of ATC sector workload under meteorological uncertainty	Prof. Carl-Herbert Rokitansky	PLUS
WP 7. Dissemination, exploitation and communication	Prof. Damián Rivas	USE
Task 7.1. Dissemination	Prof. Damián Rivas	USE
Task 7.2. Exploitation	Dr. Antonio Franco	USE
Task 7.3. Communication	Prof. Damián Rivas	USE
Task 7.4. Data management	Dr. Antonio Franco	USE
WP 8. Ethics requirements	Prof. Damián Rivas	USE
Task 8.1.Implementation of ethics requirements	Dr. Antonio Franco	USE

Table 3.2. List of deliverables

Deliverable number	WP number	Partner	Due date
D 1.1. Project management plan	WP 1	USE	T0+01 (30/06/2016)
D 1.2. TRL-Assessment report	WP 1	USE	T0+22 (31/03/2018)
D 1.3. Project results final report	WP 1	USE	T0+23 (30/04/2018)
D 2.1. Requirements and concept for EPS processing	WP 2	MetSol	T0+03 (31/08/2016)
D 2.2. Software documentation for EPS processing	WP 2	MetSol	T0+06 (30/11/2016)
D 2.3. Requirements and concept for nowcast processing	WP 2	MetSol	T0+09 (28/02/2017)
D 2.4. Software documentation for nowcast data	WP 2	MetSol	T0+12 (31/05/2017)
D 3.1. Survey questionnaire	WP 3	UC3M	T0+03 (31/08/2016)
D 3.2. Stakeholders' survey report	WP 3	UC3M	T0+06 (30/11/2016)
D 4.1. Efficiency/predictability trade-off of 4D trajectories at pre-tactical level	WP 4	UC3M	T0+09 (28/02/2017)
D 4.2. Efficiency/predictability trade-off of 4D trajectories at tactical level	WP 4	UC3M	T0+15 (31/08/2017)
D 4.3. Catalogue of case studies for robust trajectory planning	WP 4	UC3M	T0+18 (30/11/2017)
D 5.1. Methodology to assess the uncertainty of sector demand	WP 5	USE	T0+09 (28/02/2017)
D 5.2. Effects of weather uncertainty in sector demand	WP 5	USE	T0+18 (30/11/2017)
D 5.3. Catalogue of case studies for sector demand analysis	WP 5	USE	T0+21 (28/02/2018)
D 6.1. Report on evaluation and assessment of proposed solutions	WP 6	PLUS	T0+22 (31/03/2018)

D 7.1. Dissemination plan	WP 7	USE	T0+06 (30/11/2016)
D 7.2. Exploitation plan	WP 7	USE	T0+06 (30/11/2016)
D 7.3. Communication plan	WP 7	USE	T0+06 (30/11/2016)
D 7.4. Data management plan	WP 7	USE	T0+06 (30/11/2016)
D 7.5. Proceedings of TBOMet workshop	WP 7	USE	T0+22 (31/03/2018)
D 7.6. TBO-Met press release	WP 7	USE	T0+22 (31/03/2018)
D 8.1. H - Requirement No. 3	WP 8	USE	T0+01 (30/06/2016)
D 8.2. POPD - Requirement No. 2	WP 8	USE	T0+01 (30/06/2016)
D 8.3. POPD - Requirement No. 1	WP 8	USE	T0+01 (30/06/2016)

Table 3.3. List of milestones

Milestone number	WP number	Partner	Due date
MS 1. Kick-off Meeting	WP 1	USE	T0+01 (30/06/2016)
MS 2. Website construction	WP 7	UC3M	T0+01 (30/06/2016)
MS 3. SB meeting 1	WP 1	USE	T0+06 (30/11/2016)
MS 4. Approval of dissemination, communication, exploitation and data management plans	WP 7	USE	T0+06 (30/11/2016)
MS 5. Software development	WP 2	MetSol	T0+12 (31/05/2017)
MS 6. SB meeting 2	WP 1	USE	T0+12 (31/05/2017)
MS 7. Intermediate Review Meeting	WP 1	USE	T0+12 (31/05/2017)
MS 8. 2016 SID's conference papers	WP 7	USE	T0+12 (31/05/2017)
MS 9. SB meeting 3	WP 1	USE	T0+18 (30/11/2017)
MS 10. Trajectory Planning Scenarios	WP 4	UC3M	T0+18 (30/11/2017)
MS 11. Sector Demand Scenarios	WP 5	USE	T0+21 (28/02/2018)
MS 12. Workshop and demo	WP 7	USE	T0+22 (31/03/2018)
MS 13. SB meeting 4	WP 1	USE	T0+22 (31/03/2018)
MS 14. Project close-out and review meeting	WP 1	USE	T0+24 (31/05/2018)
MS 15. 2017 SID's conference papers	WP 7	USE	T0+23 (30/04/2018)

3.2 Management Structure

The management of this project requires a well-structured project organisation and a project environment that provides a framework for the consortium partners to effectively share and analyse scientific, industry, societal, economic and regulatory knowledge and insight. The project management structure is illustrated in Figure 3.1. It consists of a Project Coordinator (PC) and a Steering Board (SB) formed by members from all the partners. They are described next.

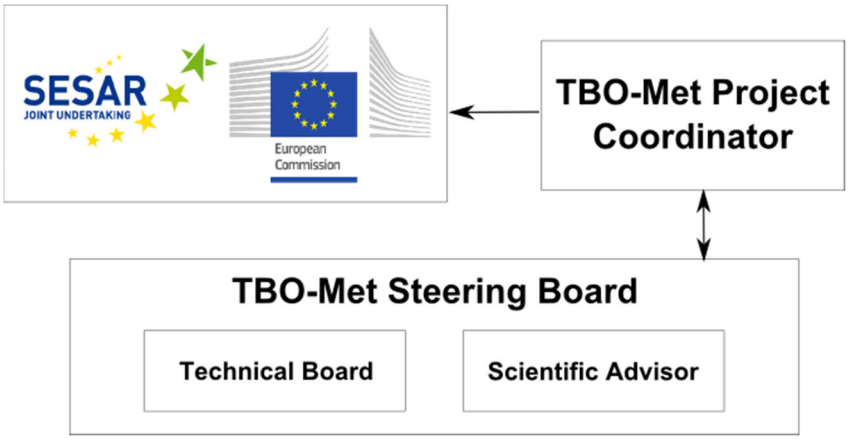

Figure 3.1. Management structure

Project Coordinator

The PC monitors the project in order to meet its objectives on time, according to the budget and quality procedures and is the intermediary between the partners and both the European Commission and SESAR JU. The PC shall be responsible for:

- Monitoring compliance by the partners with their obligations.
- Supervising the WP Leaders in their tasks.
- Collecting, reviewing and submitting reports and deliverables on the progress of TBO-Met to SESAR JU.
- Finalising the Period Technical and Financial Reports and uploading them on the H2020 Portal for assessment.
- Preparing and chairing the SB, the KOM and the periodical progress meetings.
- Settling disputes among partners.

Prof. Damián Rivas is the PC and focal point with the European Commission and SESAR JU on behalf of TBO-Met consortium. Permanent resources from the USE administrative departments will provide

assistance to Prof. Damián Rivas, enabling him to concentrate on project and consortium coordination and management.

Steering Board

The SB oversees the overall strategic and financial development of the project and resolves risk situations and administrative problems. The SB has 5 seats allocated to a technical board with all five partners represented, and 1 seat allocated to a scientific advisor.

The SB has the following responsibilities:

- Intellectual Property Rights (IPR) strategy and procedures.
- Approval of changes to the work plan.
- Decisions about evolution of the Consortium.
- Conflict resolution between partners.

Moreover, the SB is the forum to discuss issues related to:

- TBO-Met technical management.
- TBO-Met exploitation and dissemination.
- TBO-Met scientific quality.

The SB is chaired by the PC, Prof. Damián Rivas, and its composition is shown in Table 3.4. Notice that all the WP Leaders are included in the SB, which will help in performing its tasks and responsibilities.

Table 3.4. Steering Board composition

	Name	Partner
Technical Board	Dr. Juan Simarro	AEMET
	Mr. Jürgen Lang	MetSol
	Dr. Manuel Soler	UC3M
	Prof. Damián Rivas	USE
	Prof. Carl-Herbert Rokitansky	PLUS
Scientific Advisor	Prof Thomas Hauf	MetSol

The SB will meet during the regular project meetings scheduled each 6 months (MS3, MS6, MS9, MS13, see Table 3.3) and shall also convene extraordinary meetings at any time upon written request of any member. Alessandro Prister (the Project Officer) and Robin Valkenburcht (ATM expert), from SJU, will

be invited to the SB meetings. Representative individuals from the stakeholders will also be invited to participate in the SB meetings; the named individuals, and their acceptance status to participate in the SB meetings is the following:

Table 3.5. Stakeholders to be invited to participate in the SB meetings

Stakeholder	Participant	Acceptance
Eurocontrol	Sebastian Wangnick (Team Leader HMI at Eurocontrol Maastricht UAC)	Confirmed
Austro-Control	Dr. Markus Kerschbaum (Head of Development, Department of Flight Meteorology)	Confirmed
DFS Deutsche Flugsicherung GmbH	Stefan Schwanke (Department of Planning and Innovation)	Confirmed
Enaire	Carlos Caspueñas (Director of ATS, South Region)	Confirmed
Spanish National Supervisory Authority of MET Services for Air Navigation (NSA-MET)	Dr. Estrella Gutiérrez-Marco (Area Coordinator, Secretary of State of Environment)	Confirmed

4 Gantt Chart

The project schedule is illustrated in the Gant chart shown in Figures 4.1.a and b. This chart includes the duration of the work packages and the tasks, the delivery date of the deliverables, and the dates of the milestones comprising the project meetings. This chart is also provided as a separate MS-Project file.

The project meetings, along with the due dates and locations, are listed in Table 4.1. All these meetings comply with the required dates and objectives defined in Section 6 of the Exploratory Research (ER) Project Execution Guidelines document [1], and summarized in the Exploratory Research Call for Proposals [23] and in Section 5.3 of this document. Notice that, as agreed in the Kick-Off Meeting [22], the SB meeting 1 will take place in Madrid instead of Valencia, as originally planned in the Grant Agreement [2].

For the sake of completeness, an activity-on-node Pert chart showing the interrelation of the different tasks is presented in Figure 4.2. In this graphical representation the solid arrows connecting two tasks indicate a precedence relationship (as usual) and the dotted arrows indicate that the following task ends after the preceding task does, so that the relevant results from the preceding task can be taken into account in the following one even though there is not a precedence relationship between them. Note that WPs 1, 7 and 8 are not broken down into their different tasks because these are horizontal tasks that are active during the entire project.

Table 4.3. List of meetings

Meetings	Place	Due date
Kick-off meeting	Seville	T0+01 (30/06/2016)
SB meeting 1	Madrid	T0+06 (30/11/2016)
SB meeting 2	Valencia	T0+12 (31/05/2017)
Intermediate review meeting	Brussels	T0+12 (31/05/2017)
SB meeting 3	Darmstadt	T0+18 (30/11/2017)
SB meeting 4	Salzburg	T0+22 (31/03/2018)
Project close-out and review meeting	Brussels	T0+24 (31/05/2018)

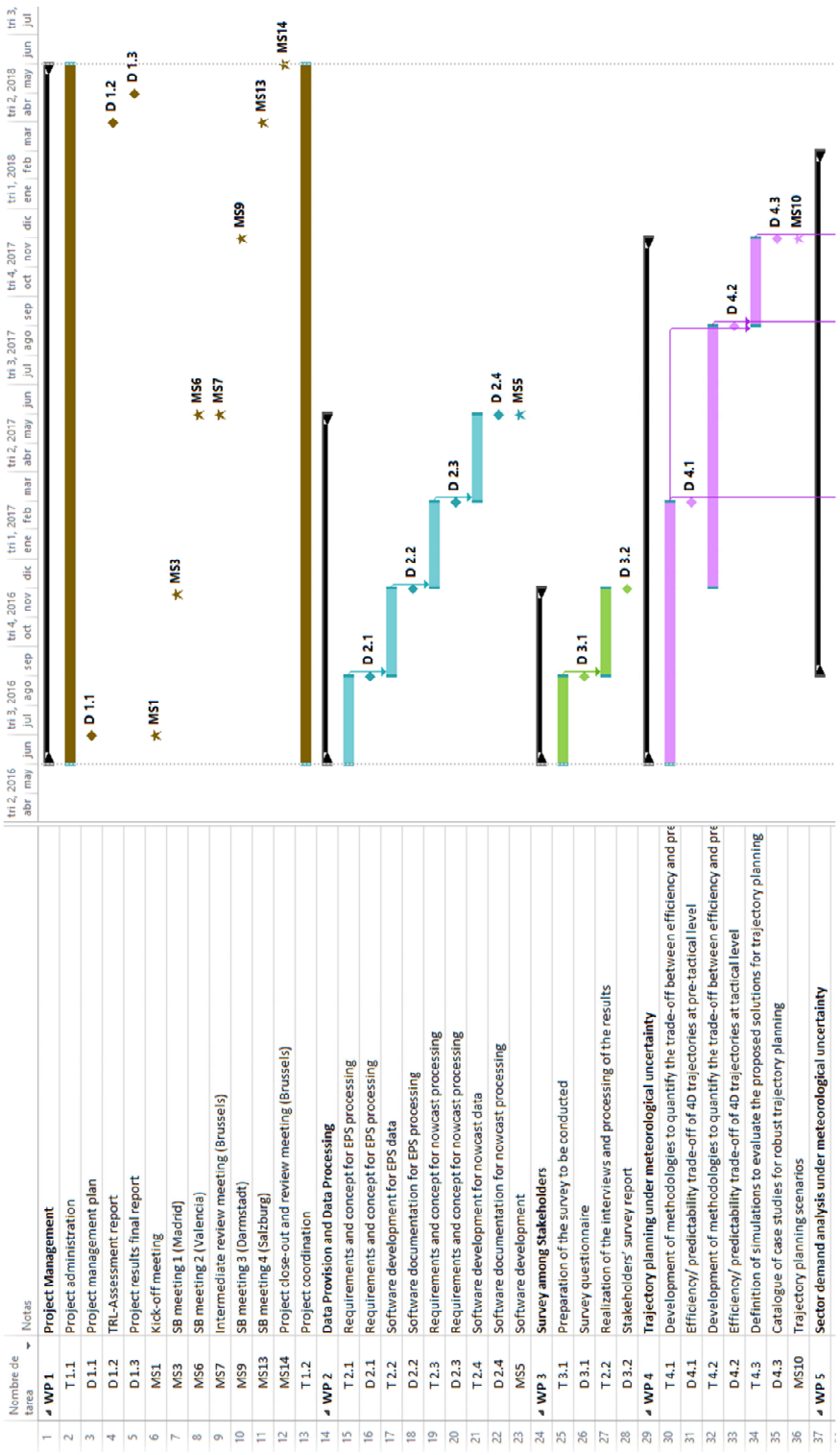

Figure 4.1.a Gantt chart

Figure 4.1.b Gantt chart

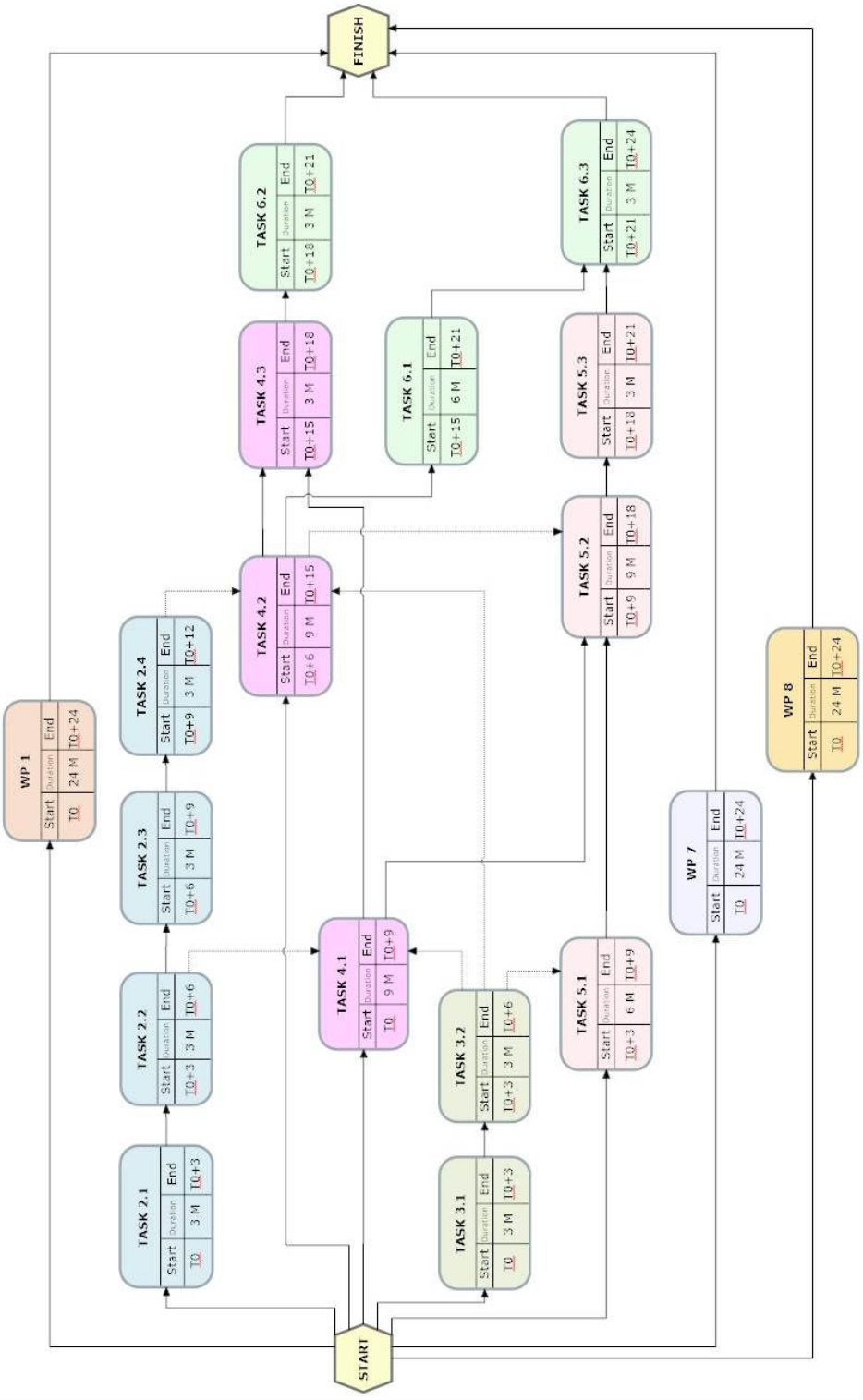

Figure 4.2. Pert chart

5 Management Plan and Procedures

The management of the project relies on the management structure described in Section 3.2, and in the tasks and responsibilities identified for the Project Coordinator and the Steering Board. The WP 1 is the work package that implements the management activities. According to the structure of WP 1, the management activities of this project are classified into two broad categories: project administration and project coordination. These activities are described next.

The management procedures to be applied during the execution of the project in accordance with the contractual references are described at the end of this section.

5.1 Project Administration

The administration of the project is performed by the Project Coordinator. It consists of:

- acting as direct liaison with SESAR JU, and
- performing the official reporting, which includes the Project Management Plan, the Progress Reports (both technical and financial), the Final Project Report, and the TRL-Assessment Report.

The PC will coordinate the preparation of the project reports to the SJU, and has final responsibility for editing according to a standard layout and for the distribution. The periodic reports will be submitted via the H2020 Participant Portal (Ref. [24]) every six months within 60 working days following the end of the Reporting Period. The Final Project Report will be delivered within 60 days from the completion of the project.

For the elaboration of the Progress Reports, each WP Leader is responsible for producing, every six months, cost statements and management control reports that contain the current status of the active work packages he is performing. These reports will also be submitted via the H2020 Participant Portal. Instructions for preparing the periodic reports and templates can be found in the H2020 Participant Portal Manual [24]. As a reference, these reports include information about:

- financial statements,
- deliverables and progress in achieving milestones,
- response to critical risks, publications, communications activities, IPRs,
- explanations of the work carried out during the reporting period and overview of the progress towards the project objectives, and

- deviations from Annex 1 of the Grant Agreement.

The Final Periodic Report covers the whole project and is composed of a Final Periodic Technical and a Final Periodic Financial part. It is delivered within 60 days from the completion of the project. The Final Periodic Technical Report is a publishable summary of the entire project. Among others, it provides:

- an overview of the project scope and objectives,
- the achieved results and main conclusions, including a self-assessment of the TRL (Technology Readiness Level) achieved at the end of the project,
- the performed communication and dissemination actions,
- the Exploitation and follow-up activities proposed for the next stage of the R&I lifecycle, and
- the socio-economic impact of the project.

The Final Periodic Financial Report includes:

- The final summary financial statement that is automatically created by the system (consolidating the data from all individual financial statements for all beneficiaries and linked third parties, for all reporting periods) and that constitutes the request for payment of the balance.
- In some cases (and for some beneficiaries/linked third parties) it must be accompanied by a certificate on the financial statements - CFS (one certificate per beneficiary/linked third party).

The Final Project Results Report (deliverable D1.3) covers all the research activities performed by the project, based on a template to be provided by the SJU. This report will be used at the Project Close-out meeting to discuss the transition to subsequent development stages including a self-assessment of the TRL achieved at the end of the project. The SJU will verify the maturity achieved in order to establish the appropriate transition of the results to subsequent phases. This report will be delivered to the SJU for approval at latest one month before the Project Close-out meeting.

5.2 Project Coordination

The coordination of the project consists of the following activities.

Monitoring of on-going work

In particular, the PC will check the fulfilment of milestones according to the means of verification established in the Grant Agreement [2] (i.e., minutes of meetings, deliverables, proceedings…), follow-up the deliverables (see the procedures described in Section 5.3), and prepare meetings to coordinate WPs and Tasks (i.e., SB meetings).

Monitoring of the adherence to the granted budget

On the basis of the cost statements received from the partners and the payments that have been made, the PC will prepare a consolidated overview of the budgetary situation of the project (i.e., the Financial Reports). The budgetary situation will be compared with the initial costs-per-year planning.

Risk management

The PC will observe the occurrence of the critical risks identified in the project. The envisioned contingency plans will be triggered if needed. In Section 6, the risk management plan is presented.

IPR management

The IPR strategy is described in detail in the Grant Agreement [2] and the Consortium Agreement [25]. It establishes detailed rules for background agreement and access rights, ownership of results, protection of results, exploitation of results, dissemination of results, transfer and licensing of results, and access rights to results. This strategy establishes the general rules for the consortium as a whole.

Throughout the execution of the project, under the request from any SB member, the SB will identify the results to be protected by IPR. In case that certain intellectual property is identified as essential for future business opportunities of the involved partners, the necessary steps will be taken to protect it. Results jointly developed will be owned according to the rules established in CA, where pair-specific rules (e.g., when collaborating in a particular task) may apply. This IPR strategy shall secure the maximum protection of all rights of the parties making it compatible with the several dissemination activities planned within TBO-Met Project.

Project quality assurance

The TBO-Met consortium brings together a group of prestigious scientists in different fields of expertise, i.e., meteorological sciences (MetSol and AEMET), mathematical optimization (USE and UC3M), stochastic systems (UC3M), uncertainty (USE), and simulation (PLUS). The consortium bring together not only academic institutions (UC3M, USE, PLUS), yet other entities from other sectors, i.e., MetSol as a German SME (Small/Medium Enterprise) and AEMET as the Spanish meteorological agency and aeronautical meteorological service provider.

TBO-Met has a strong commitment with excellent science and the SB will pursue it through the following actions:

- Reviewing work package documentation deliverables (see Section 5.3 for the description of the procedure).
- Internal peer-reviewing of conference and journal papers before submission (see Section 5.3 for the description of the procedure).

- Assessing the technical and scientific achievements of the work package outputs.
- Commenting upon work package progress with respect to the proposed schedule when appropriate.
- Providing general feedback, and when necessary, recommendations that will assist the project coordinator in fulfilling his roles.
- Establishing a strategy for dealing with scientific misconduct.

Furthermore, all activities to be conducted under TBO-Met will be done under full consideration of the standards that apply, either today or that are being considered towards the future, regarding meteorological information, TBO operational concept, trajectory information exchange, traffic flow and capacity management, simulation and assessment, etc. This will contribute to have the expected results more easily channelled towards higher TRLs (specifically, towards passing SESAR JU Gate towards ATM applications oriented research).

Mediating on eventual internal conflicts

The PC, assisted by the SB, will settle disputes among partners.

Ethics requirements compliance

The interviews foreseen in WP 3 (Survey among stakeholders) require dealing with human participants and their opinions are considered as personal data. For these reasons, the survey is subject to ethics requirements.

The PC will observe that the WP 3 complies with the ethical requirements set out in WP 8, which are described in this PMP (Section 9) and in deliverables D8.1, D8.2 and D8.3 (Refs. [26, 27, 28]). The requirements determine that Informed consent forms and Information sheets have to be provided to the participants; they are described and given in the WP8 deliverables. Along the entire process, privacy and confidentiality will be ensured.

Project impact monitoring

The PC will supervise the decision making process recommended by H2020 to either exploit/protect or disseminate/share a particular research result. Moreover, the PC will check that the envisioned communications activities are performed in accordance with the communication plan, and that the project results are made public through the dissemination ways foreseen in the dissemination plan.

5.3 Procedures

Internal review and approval of deliverables

Before the submission of a project deliverable, it will be reviewed and approved according to the following process:

1. At least 20 days before the due date of the deliverable, the WP Leader responsible of producing the deliverable will send a draft version to: 1) the members of the Technical Board participating in the WP for revision, and 2) to the PC for monitoring the on-going work.
2. Within 7 days after receiving the draft, the reviewers will provide, if any, their comments.
3. At least 5 days before the due date, the WP Leader will send a revised version of the draft addressing the comments given in the revision to: 1) the members of the Technical Board participating in the WP, and 2) to the PC for approval.
4. Before the due date, the PC will submit the approved deliverable to the SJU.

A particular case is the Project Management Plan (deliverable D1.1). It will be reviewed by all the members of the Technical Board, where all the beneficiaries are represented, since all the beneficiaries must apply the PMP.

Submission and SJU assessment of deliverables

According to Article 19 of the Grant Agreement [2], the PC must submit all the deliverables identified in its Annex 1, in accordance with the timing and conditions set out in it.

The SJU assesses the handed-over deliverable with special emphasis on the validity of its content, alignment with commitments, internal consistency and compliance with the relevant contractual provisions set forth in the grant agreement, compatibility with SJU obligatory material (e.g. templates) and other SESAR programme management documents and guidelines as detailed in the present paper (Ref. [1]).

The SJU aims to evaluate a deliverable within 60 days from the delivery, and may:

- Accept it in writing, in whole or in part, or make acceptance of the deliverable subject to certain conditions.
- Request in writing certain clarifications or additional information, as appropriate. The Consortium shall answer the SJU's request within 15 days from receipt of the SJU's request for clarifications or additional information. If, upon receipt of the clarification or additional information, the SJU does not respond within 30 days, this clarification or additional information shall be deemed accepted.
- Reject it by giving the appropriate justification in writing.

In case that clarifications or additional information are requested, the PC will forward the SJU comments to the WP Leader responsible of producing the deliverable. At most 13 days after receiving

the SJU's request, the WP Leader will send the answer to the PC and, if necessary, a revised version of the deliverable for submission.

The status of the deliverable acceptance will be considered in the related Periodic Technical/Financial Report. When relevant, it may lead to suspension of some payments in line with the Annotated Model Grant Agreement (Ref. [29]).

Documentation management, archiving, and storage

According to Section 6 of the Exploratory Research Call for Proposals [23], the SESAR 2020 word template and the SESAR 2020 power point template will be the standard templates, respectively, for all project deliverables and for all official project presentations (presentations involving SJU or external audience).

Within each phase of the writing of the deliverable, the history will be tracked following a correct completion of the Document History section of the deliverable. The coding of the deliverable edition is shown in Table 5.1.

Table 5.1. Coding of the deliverable edition

Edition	Status	Notes
00.00.01	Initial Draft	
00.00.02	Second Draft	Revision of first draft
00.00.n	Nth draft	Version ready for approval
00.01.00	First Issue	Version approved for submission
00.01.01	Revised Issue	Revision of the document following SJU assessment report (if any)
00.01.n	Nth draft	Second version of deliverable ready for approval
00.02.00	Second Issue	Version approved for submission

The deliverables will be named following these nomenclature rules:

- Naming of the deliverables: [TBO-Met]_D[X.X]_ed[Y.Y]:
- D[X.X]: deliverable number (e.g., D 1.2 is named D[1.2])
- ed[Y.Y]: edition of document (e.g., edition 00.01.02 is named ed[01.02]).

According to the Grant Agreement [2], all the partners must, for a period of five years after the payment of the balance, keep records and other supporting documentation, including the project deliverables, in order to prove the proper implementation of the action and the costs they declare as eligible. They must make them available upon request or in the context of checks, reviews, audits or investigations. The partners must keep the original documents. Digital and digitalised documents are considered originals if they are authorised by the applicable national law.

Internal peer-reviewing of conference and journal papers before submission

In the case of joint works, before the submission of a conference or journal paper, it will be internally peer-reviewed according to the following process:

1. At least 15 days before the submission deadline of the conference, in case of a conference paper, or at any time in case of a journal paper, the partner responsible of producing the paper will send a draft version for revision to: 1) the members of the Technical Board involved in the WP from which the paper is derived, and 2) to the PC for monitoring the on-going work.
2. Within 5 days after receiving the draft, the reviewers will provide their comments.
3. Within 10 days after sending the draft, a revised version of the paper addressing the comments given in the revision will be sent to: 1) the members of the Technical Board involved in the WP, and 2) the PC for monitoring the on-going work.

Project meetings

The meetings and their objectives are the following [1]:

- The Kick-off meeting aims at informing the project partners about the operational and applicable financial provisions in more details, including discussing the project objectives, organisation, deliverables, resources, planning, communication and dissemination activities and other relevant information as outlined in Annex I of the Grant Agreement [2].
- The SB meetings aims to manage the overall strategic and financial development of the project and resolves risk situations and administrative problems.
- The Project Intermediate Review meeting aims at steering the project in order to achieve the expected quality and maturity at the Project Close-out meeting.
- The objective of the Project Close-out meeting is to determine if the project indeed achieved its objectives. As applicable, the SJU will organize in conjunction with the Project Close-out meeting, a Project Review or Project Gate, aiming to assess the readiness of the project results for the next stage of the Research and Innovation lifecycle.

For the Kick-off meeting and the SB meetings, the Project Coordinator will provide to the participants, before the meeting, an agenda including the points to be addressed.

For all the meetings, the PC will prepare a presentation describing the overall status of the project and will deliver it at the meeting.

Minutes of meeting management

The minutes of the meetings will be managed according to the following process:

1. Within 10 days of the meeting, the PC will send a draft version of the minutes for revision to the members of the Technical Board that participate in the meeting.
2. Within 5 days after receiving the draft, the reviewers will provide their comments.
3. Within 10 days after sending the draft, the PC will send a revised version of the minutes to the members of the Technical Board that participate in the meeting.
4. In case that the SJU participates in the meeting, the PC will send the revised version of the minutes to the SJU for further revision.

Request for GA amendments

In general, the Grant Agreement must be amended if there are any changes required to:

- its terms and conditions (e.g. data or options specific to that agreement), or
- its annexes.

In case that one of the partners is interested in the amendment of the Grant Agreement, he will send a duly justified request to the PC, and then the PC will pass the request to the Steering Board. Within 30 days after receiving the request, the Steering Board will approve or reject the request. If the request is accepted by the Steering Board, a request for amendment will be initiated in the H2020 Participants Portal. For the H2020 policy on amendments, please refer to the H2020 User Manual (Ref. [24]) and to Article 55 of the Annotated Model Grant Agreement (Ref. [29]).

Request for PMP changes

For changes in the Project Management Plan a similar process will be followed. In case that one of the partners is interested in making a change, he will send a duly justified request to the PC, and then the PC will pass the request to the Steering Board. Within 15 days after receiving the request, the Steering Board will approve or reject the request. If the request is accepted by the Steering Board, a request for change will be sent to the SJU via the Project Officer.

6 Risk and Issues Management Plan

A risk is defined as a potential event that may negatively impact the achievement of one or more of the objectives of the project. An issue is an event that has occurred and that negatively impacts the achievement of one or more of the objectives of the project.

The objectives of the Risks and Issues Management Plan are to identify the individuals responsible for managing the risks and issues of the project, to define the risks and issues management process, and to specify the criteria for evaluating and classifying the risks and issues of the project. Next, the risks and issues management processes and the risks identified in this project are presented.

6.1 Risks and Issues Management Processes

The risks and issues management will follow the following procedure:

1. Risk or Issue identification and description.

   Each project partner is responsible for identifying and documenting risks and issues of the project, especially those related to the Work Packages in which they take part. Nevertheless, the Project Coordinator, according to his tasks and responsibilities, will monitor closely if any risk or issue arises in the project. As presented in Section 5.2, for this purpose he will check the fulfilment of milestones, follow-up the deliverables, and prepare meetings to coordinate WPs and Tasks.

   Risks and issues can be identified at any time throughout the project. Once identified, each risk and issue must be described with sufficient detail.

2. Communication of the risk or issue to the Project Coordinator.

   When a risk or issue has been identified and documented by a project partner, the identifier will communicate the risk or issue to the PC. This is in accordance with the Consortium Agreement [25], by which the partners have undertaken to notify promptly any significant information, fact, problem or delay likely to affect the Project.

3. Risk/issue classification and severity assessment.

Once the risk or issue is received by the PC, and within the next 5 days, he will examine the risk or issue to classify it (i.e., if the risk is general or specific of this project) and to perform a severity assessment, and he will notify the Steering Board.

4. Definition of mitigation/resolution actions and monitoring actions.

   Within 10 days from the notification, the Steering Board will propose: 1) the mitigation actions to be implemented, and 2) how the risk or issue is to be followed up.

5. Escalating for review and agreement in mitigation/resolution actions.

   The PC will notify the SJU the proposal given by the Steering Board prior to their implementation for further discussion. In particular, the SJU will confirm that impact rating is appropriate, the mitigation/resolution actions are appropriate and timeframes are appropriate and achievable. The mitigation/resolution actions will be implemented once they are agreed with the SJU.

6. Implementing mitigation/resolution actions and controlling their effectiveness.

   The various resolution actions associated with each risk and issue are monitored by the Project Coordinator. If the risk or issue is not forecasted to be resolved within the agreed parameters (cost, schedule and resource allocation) the risk or issue will be escalated by the Project Coordinator to the Steering Board and to the SJU.

7. Maintaining risks and issues.

   On a regular basis, risks and issues will be checked to be up-to-date, exhaustive and accurate enough. The management of project risks and issues will be done through the Periodic Reporting via the H2020 Participant Portal. The Periodic Technical Reports will address:

   a. top risks in order of criticality and/or priority; and

   b. significant issues (if applicable), with their impact, status and corrective actions.

   In particular, if a risk or issue is considered to be resolved and, because of its nature, it cannot arise again, or if the action associated to the risk or issue ends (e.g., the associated WP is successfully completed), then the status of the risk or issue will be changed from open to closed.

6.2 Critical Implementation Risks and Mitigation Actions

General risks, common to any research project and also present in TBO-Met, their impact, and the proposed mitigation measures are listed in Table 6.1. The specific risks of this project are presented in Table 6.2.

Table 6.1. General risks and mitigation actions

Risk number	Description of risk	WP Number	Proposed risk-mitigation measures
R1	Inadequate coordination	WP1	Impact: High. Probability: Low (USE has extensive experience coordinating EC projects and the USE Officials will support the Coordinator. Moreover, USE has experience in working with SESAR as Scientific Coordinator of ComplexWorld Network.). Mitigation: Discussion with SB and SJU leading possibly to changes in contract formalized by amendment to CA. Status: Open.
R2	Conflicts between partners	WP1	Impact: Medium. Probability: Low (All partners have experience in working in EU projects. Moreover, they have had successful collaborative experiences in the past). Mitigation: Any unsolved conflict will be addressed at SB level voting if disagreement persists. Status: Open.
R3	Withdrawal of partner	WP1, WP2, WP3, WP4, WP5, WP6, WP7	Impact: High. Probability: Low (All partners have shown strong commitment and interest during the preparation of the proposal). Mitigation: Discussion with SB and SJU leading possibly to changes in contract formalised by amendment to Consortium Agreement. Status: Open.
R4	Major delays in milestones	WP1, WP2, WP3, WP4, WP5, WP6, WP7	Impact: High. Probability: Low (All partners have vast experience in their disciplines, respectively. They have been solving similar problems in the past and all agree the time allocated is enough to carry out the tasks). Mitigation: Discussion between PC and WPLs to find alternatives. Status: Open.
R5	IPR issues	WP7	Impact: High. Probability: Low (A clear and detailed definition of the IPR strategy among all involved actors is stated in the Consortium Agreement and the Grant Agreement. IPR monitoring will be a recurrent agenda item in all SB meetings). Mitigation: Discussion with SB, based on signed Consortium Agreement.

			Status: Open.
R6	Loss of focus and objectives	WP4, WP5, WP6	Impact: High. Probability: Low (The SB is composed of some prestigious scientists with more than 25 years of experience who have worked during the last 5-10 years in the field of ATM research, very involved in SESAR activities and projects. Moreover, the SB has a Meteorological Office on board, a meteorological scientist as scientific advisor, and the SJU and some stakeholders will be invited to the SB meetings. Lastly, the survey among the different stakeholders will allow to keep the TBO-Met focus aligned). Mitigation: Internal discussion within the SB and discussion with SJU. Status: Open.
R7	Poor quality of technical and scientific documentation	WP1, WP2, WP3, WP4, WP5, WP6, WP7	Impact: High. Probability: Low (TBO-Met will pay important attention to quality assurance and management. Reports will be reviewed and scientific submission will be internally peerreviewed). Mitigation: Discussion between PC and WPLs. Status: Open.

Table 6.2. Specific risks and mitigation actions

Risk number	Description of risk	WP Number	Proposed risk-mitigation measures
R8	Lack of input data for research	WP2, WP4, WP5, WP6	Impact: High. Probability: Low (Met data will be provided by AEMET, nevertheless data are available on a free-basis at TIGGE databases; inputs between WPs will be coordinated in advance to establish homogeneous formats). Mitigation: If necessary Non-Disclosure Agreements will be signed between the data supplier and the researchers. Status: Open.
R9	Lack of experts to be interviewed for the survey	WP3	Impact: Medium. Probability: Low (SB members are involved in ATM research and are in general well connected. They attend regularly to conferences, e.g., SIDs, or congresses, e.g., World ATM Congress, and carry out projects with the industry, e.g., Boeing, Austro Control, DWD, MeteoFrance, etc.). Mitigation: Discussion between PC and WPLs to find alternatives. Status: Open.

R10	Unavailability of software/simulation facilities	WP6	Impact: High. Probability: Low (PLUS uses its own facilities for several projects. They are robust enough and there is no need for further development to carry out the task foreseen in TBO-Met). Mitigation: Discussion between PC and WPLs to find alternatives. Status: Open.
R11	Unauthorized disclosure of the information provided during the interviews, and/or the identities of the interviewees	WP3, WP8	Impact: Medium. Probability: Low (Completed questionnaire will not contain any personal information that might allow to connect the opinions to the person who has expressed them). Mitigation: Appropriate data management procedures. Status: Open.
R12	No participation of stakeholders in the SB meetings	WP1, WP2, WP3, WP4, WP5, WP6, WP7	Impact: Low. Probability: Low (All the partners have regular contact with the stakeholders identified in the Kick-Off meeting [22]). Mitigation: The partner who hosts the SB meeting will make his best effort to convince at least one local stakeholder to attend the meeting. Status: Open.

7 Communication Plan

The goal of the Communication Plan is to promote the project and its results. For this purpose, the plan presented in this section defines clear objectives and sets out a concrete strategic planning for the communication activities. This plan satisfies the content and activities identified in Section 4.1 of the Exploratory Research (ER) Project Execution Guidelines document [1], the article 38.1 of the Grant Agreement [29] concerning the communication activities of the partners, and the instructions provided in the H2020 Communication Guide [30] with regard to the communication strategy. Next, the communication elements and the communication activities of the Communication Plan are presented.

7.1 Communication Elements

Point of contact

The communications point of contact of this project is the Project Coordinator, Prof. Damián Rivas. His contact details are the following:

Prof. Damián Rivas
Department of Aerospace Engineering
School of Engineering
C/ Camino de los Descubrimientos s/n
41092 Seville (Spain)
Tel: +34 954 48 61 29
E-mail: drivas@us.es
Website: https://tbomet-h2020.com

Communication objectives

The TBO-Met results will be targeted to the following audiences:

1. General public (GP).
2. Undergraduate and graduate students (UGS).
3. Research and scientific community (RSC).
4. Industrial and intellectual property agents (IPA).
5. Institutions (I).

The goals of the TBO-Met communication strategy are different for each audience:

1. **Targeted to GP:** Ensure that the research activities are made known to society at large in such a way that they can be understood by non-specialists, thereby improving the public's understanding of science and technology. Establish a concern on how European collaboration and funding contributes to society.

2. **Targeted to UGS:** Wake up interest to follow scientific careers, especially to join TBO-Met groups and follow PhD studies and develop BSc and MSc thesis.

3. **Targeted to RSC:** Maximize the dissemination, including other scientific disciplines; enhance excellence through discussions; enhance scientific reputation; find follow up ideas and collaborations.

4. **Targeted to IPA:** Anticipate which results could be protected and how to do it; attract the interest of the industry; find potential partners for higher TRL proposals within SESAR H2020 and/or other European/National Projects; find potential clients for existing products/services and/or potential new products/services to be developed.

5. **Targeted to I:** Draw the attention of different institutions, e.g., European Commission, National Governments, Regional Governments, Regulators (ANSPs, ICAO, SESAR), to make them aware of TBO-Met results and make them visible to their agendas. This will facilitate the allocation of more funding and the revision/modification of standards.

High level messages about the project

The benefits that the project is expected to bring can be expressed in the following messages:

- *TBO-Met will allow a better understanding of the effects of meteorological uncertainty in Trajectory Based Operations.*
- *TBO-Met will develop novel techniques to manage meteorological uncertainty information.*
- *TBO-Met will improve the predictability of aircraft trajectories when subject to uncertain wind and uncertain convective regions.*
- *TBO-Met will increase the accuracy of the prediction of sector demand when uncertain wind and uncertain convective regions are taken into account.*

Once the project is finished, these messages will be updated with the results obtained.

Short project description

Next, a short description of the project in language suitable for non-experts is provided:

Aviation is greatly affected by meteorology. Airlines plan the aircraft trajectories to take advantage of tailwinds and avoid headwinds to save fuel and reach their destinations earlier, and they avoid storms to keep the highest safety levels. The workload of an air-traffic controller grows with the number of aircraft present in his sector, and this number is also greatly affected by the presence of storms. If a trajectory is to be planned or the workload is to be estimated, a prediction of the future meteorology is required. However, predictions are inherently uncertain. The present state of the atmosphere is not perfectly known and its evolution along time is subject to instabilities not always well modeled. If the time horizon is large, the prediction can be very far from reality. However, in the last years the meteorological offices have made many advances. Today, they do not provide a unique forecast, but an ensemble of them, aiming to bracket the reality. The dispersion of these forecasts can be seen as a measure of uncertainty. The objectives of the TBO-Met project are to use these new predictions in the aviation sector. In particular, the objectives of TBO-Met are: 1) to advance in the understanding of the effects of meteorological uncertainty in the aircraft trajectories, 2) to quantify and reduce the effects of uncertainty in the trajectories, and 3) to pave the road for a future integration of the management of meteorological uncertainty into the air traffic management system.

Calendar of planned communication activities

The dates at which the different communication activities will take place are presented in Table 7.1, Section 7.2.

Metrics used for measuring success of the communication activities

The metrics proposed to measure the success of the communications activities are the following:

- Number of results obtained in an internet search engine (e.g. Google) when all the following search terms are used: *"TBO-Met" "meteorological" "uncertainty" "trajectory".*

  This metric measures how often the project is cited in the web, from all the audiences. It will be reported every six months.

- Number of visitors to the project website.

  This metric measures how many people is interested in the project, from all the audiences. It can be gathered from free web analytics services as, for example, Google Analytics. It will be reported every six months.

- Number of attendants to those communication activities where the project's results are presented.

  This metric measures the impact of the project results on the audience to which the activity is aimed. It will be checked at each communication activity.

Information on funding

Any communication activity related to the action (including in electronic form, via social media, etc.) will display the SJU logo and the EU emblem, and will include the following text:

"This project has received funding from the SESAR Joint Undertaking under grant agreement No 699294 under European Union's Horizon 2020 research and innovation programme".

When displayed together with another logo, the SJU logo and the EU emblem will have appropriate prominence.

Disclaimer excluding SJU responsibility

The communication activity related to the action will indicate that it reflects only the author's view and that the SJU is not responsible for any use that may be made of the information it contains.

7.2 Communication Activities

A detailed list of TBO-Met intended communication activities, indicating its target audience, is given in Table 7.1.

Table 7.1. Communication activities

Number	Communication activity	Target Audience	Date
CA1	Participation at each SESAR Innovation Days with a poster describing the status of the project.	RSC, IPA, I	T0+05 (31/10/2016) T0+17 (31/10/2017)
CA2	Participation at SESAR Innovation Days with scientific papers showing the progress of the project. For 2016, the objective is 2 papers.	RSC, IPA, I	T0+05 (31/10/2016) T0+17 (31/10/2017)
CA3	Publication of papers in scientific journals: Journal of Guidance, Control and Dynamics; Aerospace Science and Technology; Transportation Research Part C: Emerging Technologies; and Transportation Research Part D: Transport and Environment. The objective is 2 papers for 2017 and 2 papers for 2018.	RSC, IPA	2017 and 2018
CA4	Participation and presentation at scientific conferences: International Conference on Research Air Transportation (ICRAT) and USA/Europe ATM Seminar. The objective is 2 papers per year.	RSC, IPA	T0+12 (31/05/2017) T0+24 (31/05/2018)

CA5	Organisation of a dedicated workshop to present the project's results. This workshop will be organized by PLUS by the end of the project.	RSC, IPA, I	T0+22 (31/03/2018)
CA6	After the workshop, publication of TBO-Met press describing the major outcomes of the project	GP, UGS, RSC, IPA, I	T0+22 (31/03/2018)
CA7	Creation of TBO-Met website describing the project and where the abstracts of project deliverables and publications can be made available with a regular update. URL: https://tbomet-h2020.com	GP, UGS, RSC, IPA, I	T0+01 (30/06/2016)
CA8	Distribution of brochures/dossiers/presentation in seminars and workshops. The first two events are the ComplexWorld 2016 Event organised by SESAR ComplexWorld Network, which will be held in September in Cologne; and the Meteorological Uncertainty and ATM Workshop organised by USE and UC3M, in November in Madrid.	RSC, IPA	Along the project
CA9	Presence in social networks with the creation of a LinkedIn group.	RSC, IPA	T0+01 (30/06/2016)
CA10	Internal bulletins communicating key events (Kick-Off Meeting, Workshops).	GP, UGS, RSC	Along the project
CA11	Publication of a summary of the project's results in the ComplexWorld Network Wiki, hosted by Eurocontrol.	RSC, IPA, I	Along the project
CA12	Description of the project in the ComplexWorld Network Blog.	RSC, IPA, I	T0+01 (30/06/2016)
CA13	Description of the project at undergraduate and graduate courses offered by the universities. USE offers two courses which deal with ATM: 1970053 – Air Traffic Management (BSc Aerospace Engineering), and 51430024 – Advanced Air Traffic (MSc Aeronautical Engineering); and UC3M offers the course 296 – 12437 Air Navigation Systems where the SESAR programme is described.	UGS	Along the project
CA14	Participation on the science week that will take place in Madrid in November 2017.	GP, UGS	T0+17 (31/10/2017)

8 Dissemination and Exploitation Plans

Exploitation and dissemination are integral part of the European research and innovation funding. In this section the Dissemination and Exploitation Plans are described. These plans addresses the requirements defined in Section 4.2 of the Exploratory Research (ER) Project Execution Guidelines document [1] and articles 28 and 29 of the Grant Agreement [29].

TBO-Met expected results will go through the decision process recommended by H2020 as illustrated in Figure 8.1, complying with both the dissemination plan and the data management plan, including also any decision to be taken to exploit/protect certain results that might be subject to a patent in the future.

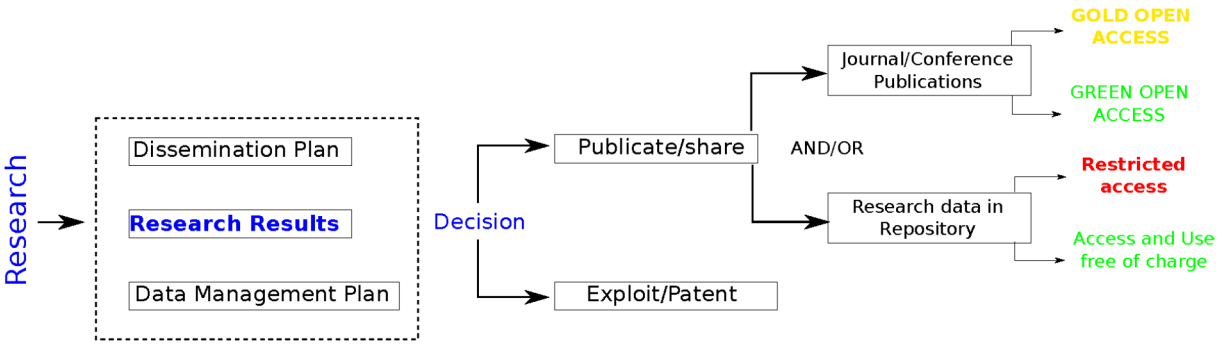

Figure 8.1. Dissemination decision process

8.1 Dissemination Plan

The dissemination of scientific discoveries is one of the inherent activities of TBO-Met project. In order to enhance excellence in science, TBO-Met has a commitment to deliver top quality research, attending to conferences with international peer review and proceedings publication, yet to publish in top ranked JCR journals and also publish according to the open access philosophy. Other activities oriented towards the dissemination of research results include: the elaboration of the project website and the organization of a workshop (including the publication of its proceedings).

According to the Article 29.1 of the Grant Agreement [2], prior notice of any planned publication shall be given to the other partners at least 45 calendar days before the publication.

TBO-Met project website

A crucial component of the TBO-Met dissemination strategy is a high-quality project website. The public section will provide ample and consistent information about all aspects of the TBO-Met project, with the goal of positioning the TBO-Met website as a prime information source for relevant scientific and technical information. The vast majority of the TBO-Met deliverables are public, and full access to these will be provided through the website. The website will also contain:

1. lists of publications and links to open-access repositories;
2. copies of technical documentation;
3. downloadable software;
4. information about project partners;
5. copies of presentations;
6. public data and results;
7. and links to the Horizon 2020 programme and to related research projects in order to highlight the role played by TBO-Met within the broader SJU research framework.

Dissemination through JCR journals

Some of the international Journals in which the research members intend to publish are:

1. Journal of Guidance, Control, and Dynamics (JCR 2015 Eng. Aerospace: Impact factor 1.651; 4/30 Q1).
2. Aerospace Sci. and Tech. (JCR 2015 Eng. Aerospace: Impact factor 1.751; 2/30 Q1).
3. Transp. Research Part C: Emerging Technologies (JCR 2015 Transp. Sci. and Tech.: Impact factor 3.075; 5/32 Q1).
4. Transp. Research Part D: Transport and Environment (JCR 2015 Transp. Sci. and Tech.: Impact factor 1.864; 12/32 Q2).

These journals are top ranked in their respective categories and the research members have already published past work therein. The commitment to publish in these top-ranked journals will certainly enhance the scientific excellence of the project.

Dissemination through peer-reviewed international conferences

Some of the international conferences to which the research members will attend and present TBO-Met results are:

1. SESAR Innovation Days (SID).
2. International Conference on Research in Air Transportation (ICRAT).
3. USA/Europe ATM Seminar. (ATM Seminar).

All of them include an international peer review committee, publish proceedings, and are well recognized in ATM forums as the most relevant conferences. The research members have already attended to past editions of these conferences. The attendance to this conference will also enhance links with other institutions and/or industrial actors.

Open access

According to the Grant Agreement [2], open access (free of charge online access for any user) to all peer-reviewed scientific publications relating to the project's results must be ensured. To fulfil this requirement, within six months of publication, the publication will be deposited in an open access repository, for example, the EC repository OpenAire.

Furthermore, since a central aim of this consortium is to provide benefit to the European community, some of the project partners may be either using open source code in their deliverables or contributing their deliverables to the open source communities.

TBO-Met Workshop

As a final step in the dissemination plan, the TBO-Met consortium will organize a workshop dedicated to the topic "Meteorological Uncertainty Management for Trajectory Based Operations". We believe that bringing together researchers on this particular topic is of major interest towards building a network and potentially build up collaborations and consortiums for projects. USE and UC3M are members of the networks ComplexWorld and HALA!, which organize annual conferences on ATM-related topics and include dedicated workshops. Moreover, USE has experience in organizing dedicated workshops in the following topics: "Uncertainty in ATM" and "Air Transport Network: an Integrated View", as part of its activities in the ComplexWorld Network.

This workshop will be hosted by PLUS, will take place near the end of the project and will have two major components:

1. a technical part, which will include the communications by the participants, and
2. a demonstration part, where, using PLUS simulation environment, we will show the benefits of TBO-Met and our readiness for TRL2.

The final dissemination item will be the publication of the workshop proceedings, which corresponds to deliverable D 7.5.

Information on funding

Any dissemination of results (in any form, including electronic) will display the SJU logo and the EU emblem, and will include the following text:

"This project has received funding from the SESAR Joint Undertaking under grant agreement No 699294 under European Union's Horizon 2020 research and innovation programme".

When displayed together with another logo, the SJU logo and the EU emblem will have appropriate prominence.

Disclaimer excluding SJU responsibility

Any dissemination of results will indicate that it reflects only the author's view and that the SJU is not responsible for any use that may be made of the information it contains.

8.2 Exploitation Plan

A goal of this project is to ensure an effective exploitation of achieved results, including any action needed to protect certain results that could be considered strategic for further research and/or commercial uses. Each beneficiary will examine the possibility if protecting its results and will adequately protect them.

The SB meeting will be the forum to discuss, with all the partners, those aspects related to intellectual property rights. As the project evolves, the particular exploitation interests of each of the partners (e.g., for further research, for the development of products, for the provision of services) will be identified, the IPRs and data sharing will be managed to ensure the timely conduction of intended research activities, and the proper actions will be taken in order to protect and/or patent a particular research result.

TBO-Met will seek a fair equilibrium between disclosing information and products to the public; and developing patents in order to protect strategic ideas that might lead to future commercialisation. The dissemination activities shall be compatible with the protection of IPR of the institutions involved.

The exploitation strategy for the TBO-Met project has 2 main threads:

1. The 1st thread is through the exploitation of knowledge that will be gained during the course of the project to produce new products and services, e.g. MetSol (meteorological services), PLUS (simulation facilities) and AEMET (new meteorological products). Overall, MetSol, PLUS, and AEMET partners in the project provide expertise in standardization, sophisticated tools, applications to describe use cases, and to perform simulation assessment, thus contributing to the expected impact of TBO-Met and potential exploitation of results.
1. The 2nd is through the protection of certain research result that could be considered key for further research. This will be the primary thread for the academic institutions in TBO-Met, i.e., USE and UC3M. Moreover, there will be significant spinoff advantages in terms of the direct and indirect involvement and skills development of MSc and PhD students in an area of key and increasing European interest, namely meteorological uncertainty in aviation studies. This meets urgent commercial needs for skilled specialists in this area, resulting in indirect exploitation.

9 Implementation of Ethics Requirements

The interviews foreseen in WP 3 (Survey among stakeholders) require dealing with human participants and some data related to them. Hence, the ethics issues identified in this project are “Human beings” and “Personal Data”, according to the ethics self-assessment guidance document, Ref. [31]. This document states that the way to deal with ethical issues is:

1. complying with ethical principles and applicable international, EU and national law; and
2. obtaining certain documentation: ethics approval (if required), authorization for data collecting and processing (if applicable), and informed consent of the research subjects or data subjects.

This section is organized as follows. First, a set of ethical principles are stated below in Section 9.1. Then information relative to identified ethics requirements is given in Section 9.2. Finally, the ethics requirements documentation that must be kept on file is included in Section 9.3

9.1 Ethical Principles

For this project, the following set of general ethical principles have been identified, based on the EU Directive 2001/20/CE, and the European Code of Conduct for Research Integrity.

1. Primacy of the human being.
2. Balancing benefits against risks.
3. Voluntary, free and informed participation of subjects.
4. Right to privacy.
5. Individual liability of researchers.
6. Integrity in scientific research.

These ethical principles are described in deliverables D8.1, D8.2 and D8.3 (Refs. [26, 27, 28]).

9.2 Ethics Requirements

In the project Grant Agreement [2], several ethics requirements that the project must comply with were identified and included as deliverables in WP 8. The identified ethics requirements are:

1. Human beings – Requirement Number 3

   Detailed information on the informed consent procedures that will be implemented is provided in deliverable D8.1.

2. Protection of Personal Data – Requirement Number 2

   Detailed information on the procedures that will be implemented for data collection, storage, protection, retention and destruction and confirmation that they comply with national and EU legislation is provided in deliverable D8.2.

3. Protection of Personal Data – Requirement Number 1

   Detailed information on the informed consent procedures that will be implemented is provided in deliverable D8.3.

9.3 Ethics Requirements Documentation

In order to give consent to participate in the survey and to collect and process personal data, information sheets must be given along with the corresponding informed consent forms. In particular, the following sheets and forms will be given:

- Information sheet for participation in TBO-Met survey (its content is included in deliverable D8.1).
- Informed consent form for participation in TBO-Met survey (its content is included in deliverable D8.1).
- Information sheet for data collection in TBO-Met survey (its content is included in deliverable D8.3).
- Informed consent form for data collection in TBO-Met survey (its content is included in deliverable D8.3).

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