PJ18.W2 4DSkyways
Solution 53 Current Research Activities

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Engage KTN - Thematic Challenge 2
Data-driven trajectory prediction, 25/01/2021

ENAIRE
CRIDA
I+D+i - ATM
4DSkyways
Engage

1 PJ18-W2 Current Research Activities

2 ENAIRE Use Case

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4 Conclusions

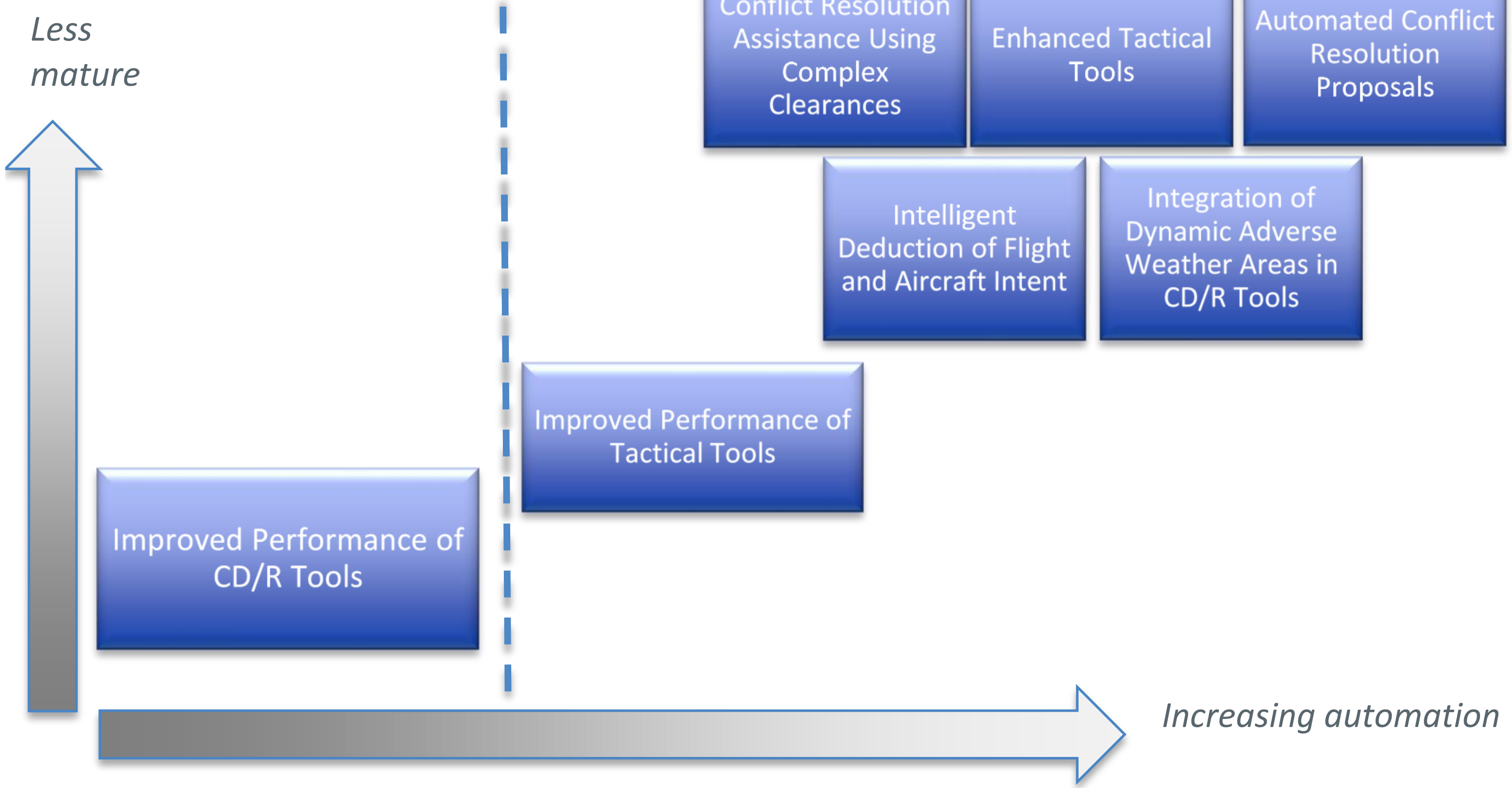
Acknowledgment!

- ***PJ18.W2 – 4D Skyways – Solution 53***
  Improved Ground Trajectory Predictions enabling future automation tools.
- PJ.18 W2 4D skyways | Programme | H2020 | CORDIS | European Commission (europa.eu)
- ***This project has received funding from the SESAR Joint Undertaking under the European Union's Horizon 2020 research and innovation programme under grant agreement No 872320.***

Current Research Activities (All partners)

PJ.18-W2-53B
Improved Performance of CD/R Tools Enabled by Reduced Trajectory Prediction Uncertainty

PJ.18-W2-53A
Increased Automation in Planning and Tactical Separation Management



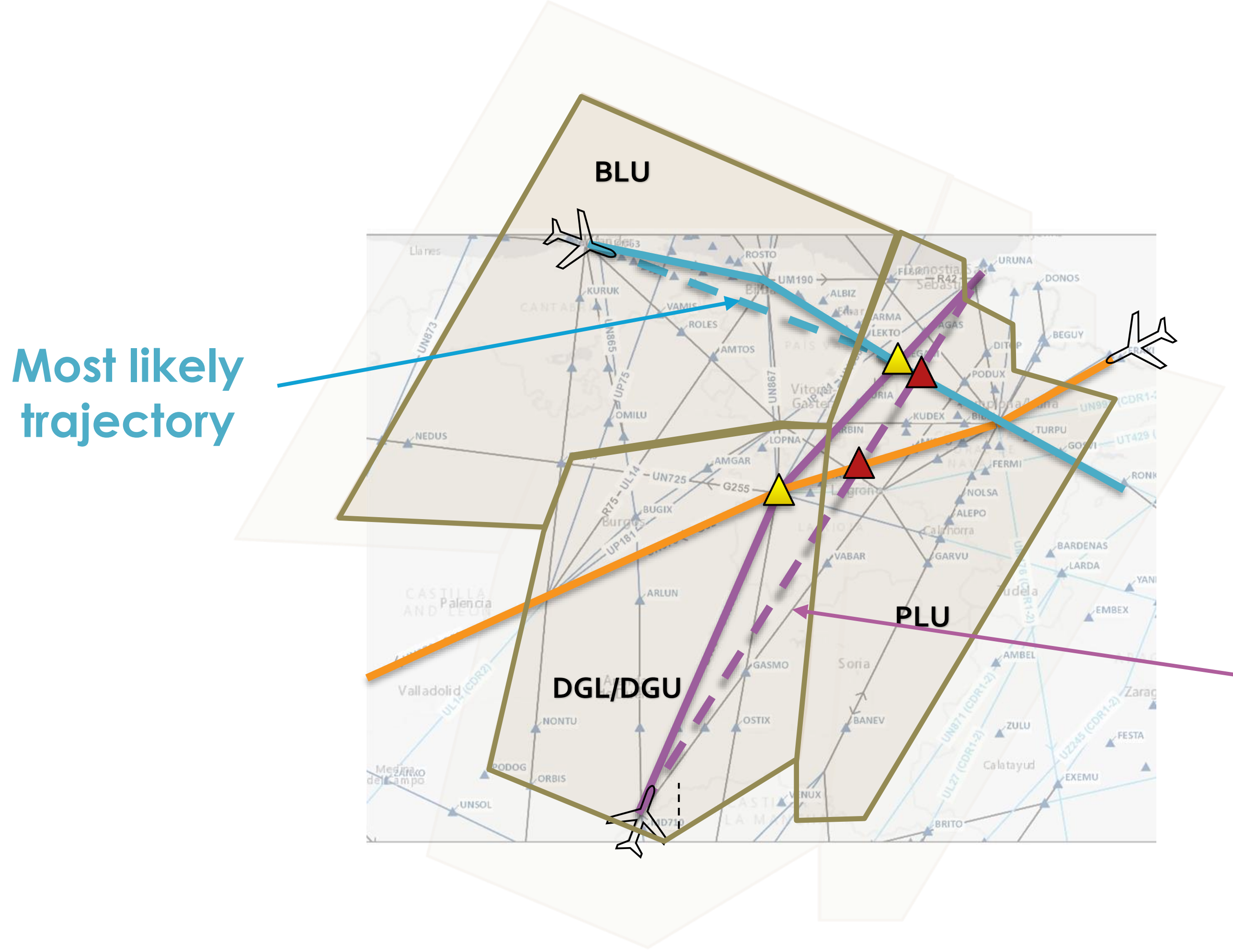
EPP
Aircraft Predicted Trajectory

ADS-C
For non-conforming Aircraft

CDR
ML for identification and resolution

ENAIRE's USE CASE

Operational Use Case



Real Case
(Provision of Planning Separation Assurance)

Look Ahead Time ~15 mins.

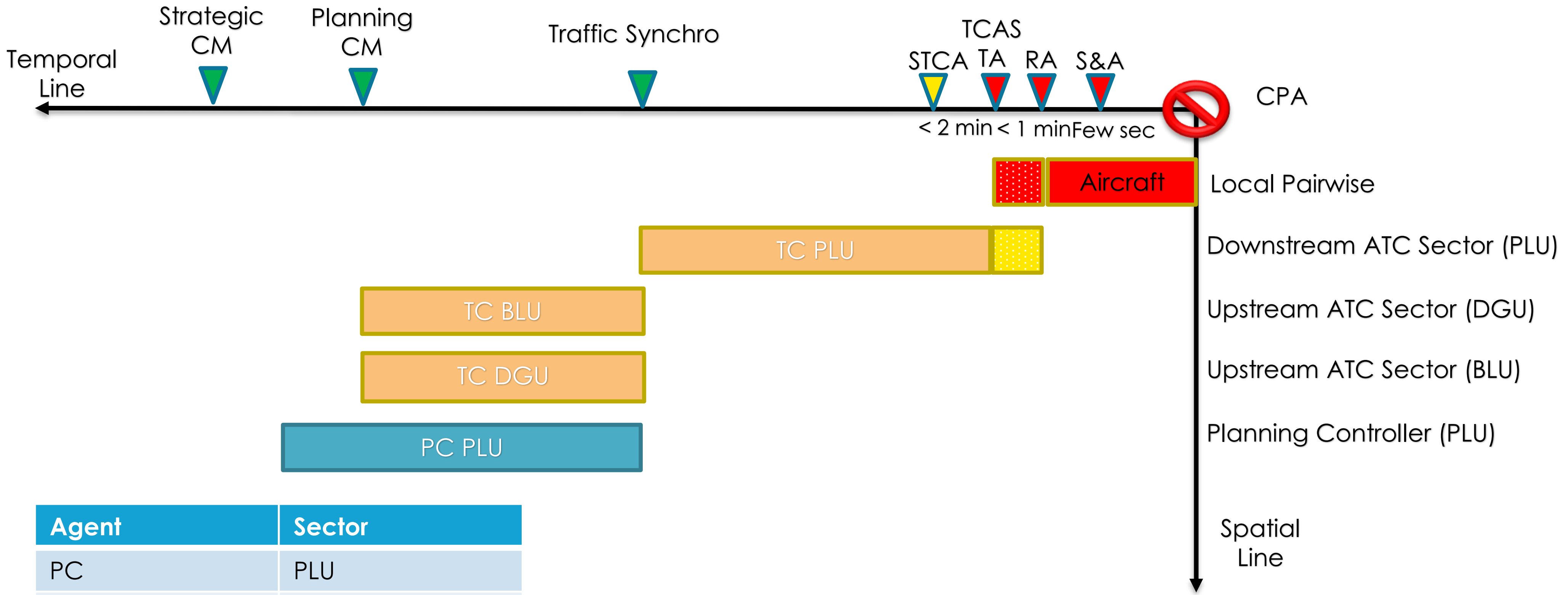
Example

RYR51XA Climbing
DAL476 Cruise

1. Max configuration (BLU,DGL, DGU, PAU)
2. DAL476 is in DCT to crossing point. RYR51XA follows the FP.
3. Vectors were given at the sector boundary after coordination between BLU and PAU (About DAL476)
4. **95%** probability conflict was identified by prototype, where the aircraft where at the boundaries of DGL / BLU respectively

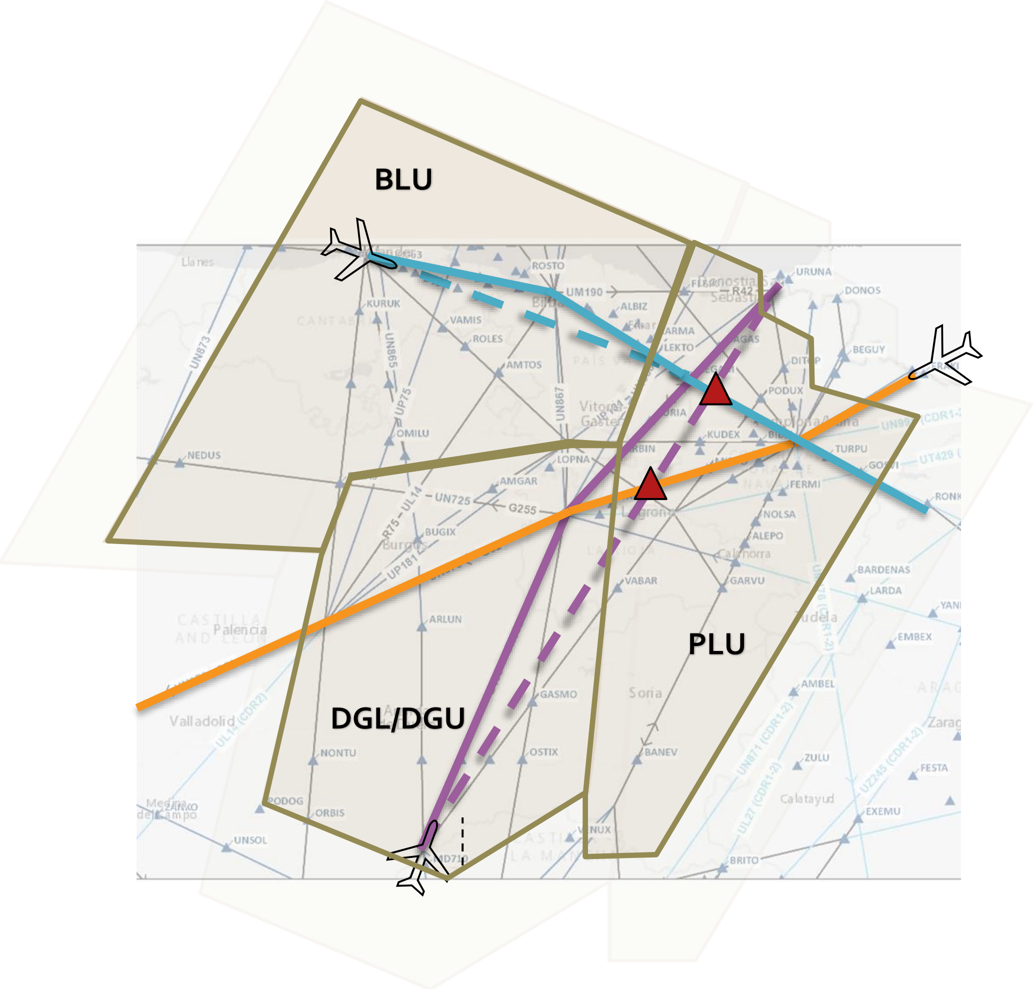
Resolution Applied in the Boundary of the Sector

Agents Involved



Agent	Sector
PC	PLU
Upstream TC	DGU
Upstream TC	BLU
TC associated to PC	PLU
Aircraft 1	DAL476
Aircraft 2	RYR51XA

USE CASE
Operational Use Case

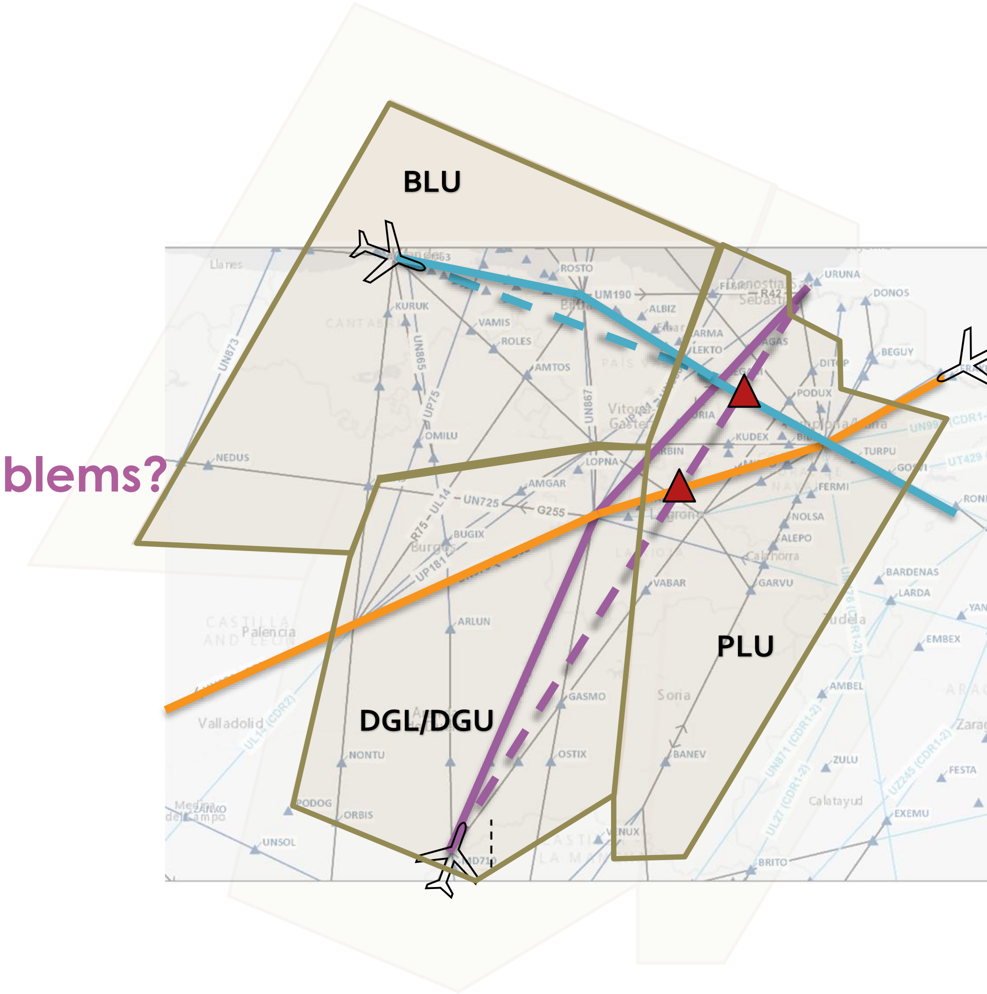


USE CASE
Decision Making Process

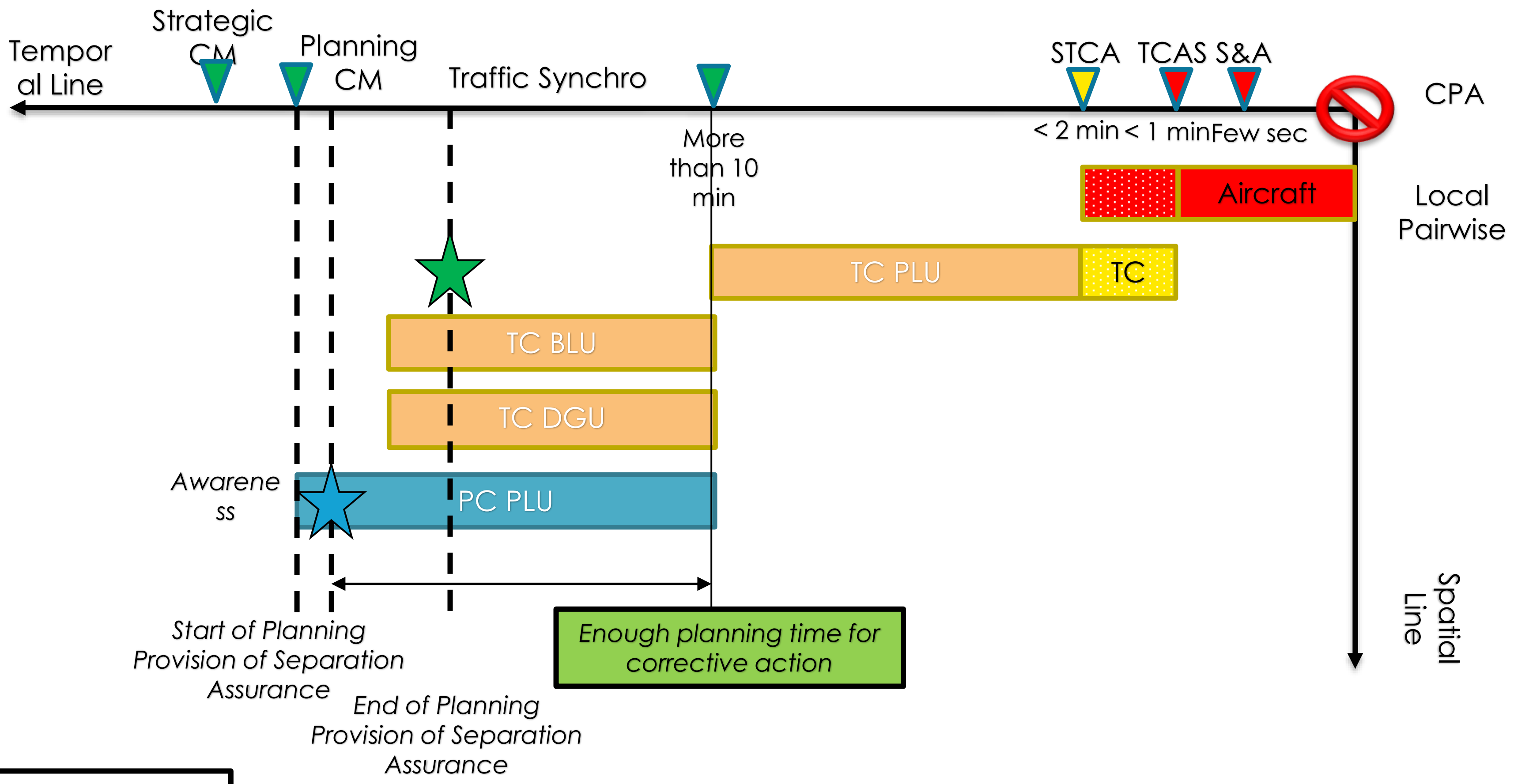
Trigger → Assess entry conditions and desired/planned profile through AoR/AoI → Determine planning problems at offered entry conditions → Problems?

YES

NO



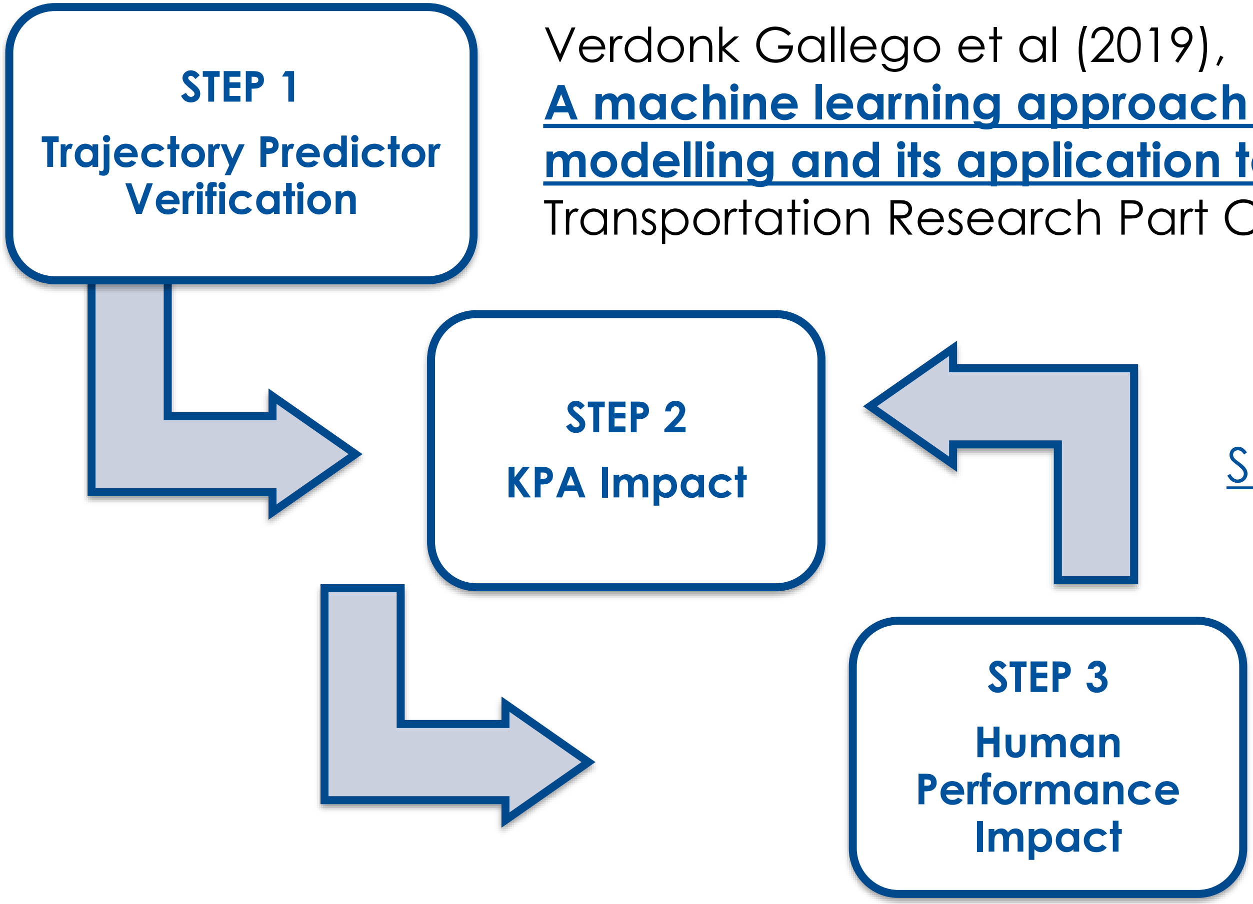
Success end state



Success End State:

1. The PC gains awareness of potential interactions with enough dwell time in the AoI to execute effectively the *Provision of Planning Separation Assurance* function.

Approach
Overview



Verdonk Gallego et al (2019),
[A machine learning approach to air traffic interdependency modelling and its application to trajectory prediction]
Transportation Research Part C: Emerging Technologies

SESAR Performance Framework

Automation

Approach

Step 1: Trajectory Predictor Verification

Objectives

To **characterise the TP performance (accuracy) benefits** that can be brought by incorporating contextual factors in a sequential manner in terms of the Look-Ahead Time.

Methodology

Statistical Analysis (Flight Intent; Aircraft Intent; Computation Engine)

1. **ML Flight Intent**
   1. **XGBOOST for TOD; TOC; (incorporating EPP Data)**
   2. **Prior characterisation + XGBOOST for ATC Intent (Direct Route)**
   3. **Prior characterisation depending on probabilistic weather-restricted area**
2. **Aircraft Intent;**
   1. **Study of the vertical guidance mode for TP Vertical prediction (EPP)**
3. **Computation Engine**
   1. **Use of Neural Networks based on flow-abstractions**
   2. **Performance of ensemble of Neural networks**

Output

Horizontal and Vertical Accuracy depending on variable Look-Ahead Time

Approach
Step 2: KPA Impact. Overview

Objectives

To **assess the performance benefits** that can be brought by the solution (i.e. generating a probabilistic view of the trajectory in the AoI, derived from the planned trajectory)

Methodology

Fast Time Simulations; Modelling of CDR depending on performance of TP for different Look-Ahead Times

Approach

Reference Scenario ⟷ **Solution Scenario**

ATC Model

Enhance the situational awareness of the PC (i.e. provision of Planner Separation Assurance) by generating a probabilistic view of the trajectory in the AoI, derived from the planned trajectory.

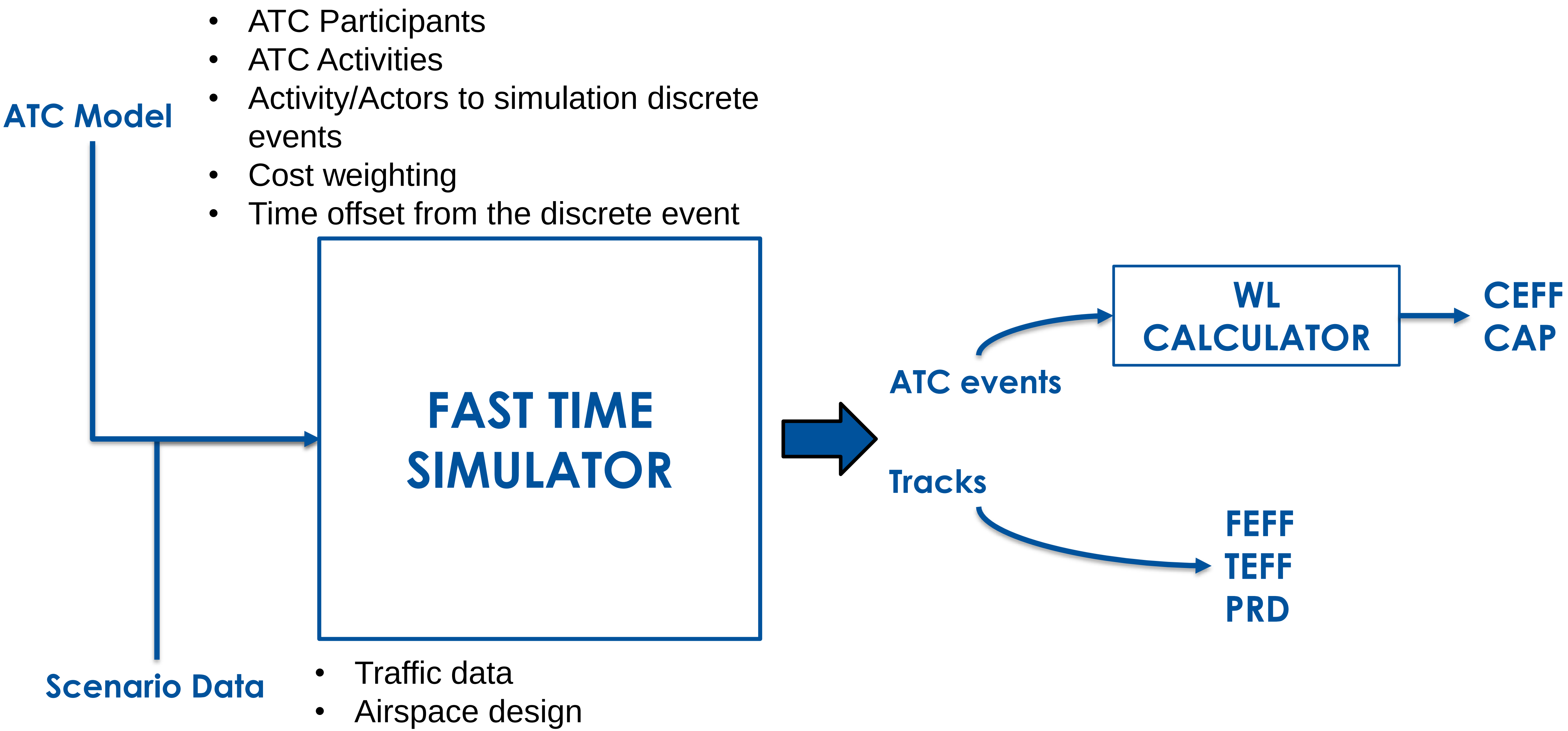
Current operating method

ATC behaviour according to the improvement of the PC situational awareness

Validation Exercise

Step 2: KPA Impact. Fast Time Simulation

Model



Some Thoughts

- We need an (accepted) framework for measuring **Trajectory Prediction** performance
- It is worthy to consider what is the **operational improvement** we are considering from the very beginning
- Assessing the **benefits** for the overall **ATM Performance**
- Small steps, but considering the “deployment phase” as much as possible