DIAPasON: A Data-driven approach for Dynamic and Adaptative trajectory PredictiON

Engage Thematic Challenge 2 Workshop
Athens, December 2nd 2019

José Manuel Cordero

SESAR JOINT UNDERTAKING

Founding Members
EUROPEAN UNION EUROCONTROL

DIAPasON Project

- **DIAPasON:** A **Data-driven** approach for **Dynamic** and **Adaptative** trajectory PredictiON

- Engage KTN – Thematic Challenge 2: Data-driven Trajectory Prediction

- **Objective**: **Methodology for TP and traffic forecasting in pre-tactical phase (T0-[1,6] days)**
    - Adjusted to different time scales (planning horizons), with different levels of predictability (seamless)
    - Model that considers tactical data to validate/enhance the pre-tactical prediction, incorporating uncertainty to TP.
    - Data-driven, Dynamic, and adaptative TP framework
        - **Data-driven:** Outcomes based on data análisis and interpretation
        - **Dynamic:** Adjusted to different planning horizons
        - **Adaptative:** Enhanced iteratively with new tactical data
    - The methodology will be validated in a Use Case

DIAPasON Consortium

CRIDA(leader) – *Operational, Data Management*

Deep Blue – *Scenarios, Validation*

ZenaByte – *Models, Machine Learning – Spin off University of Genova*

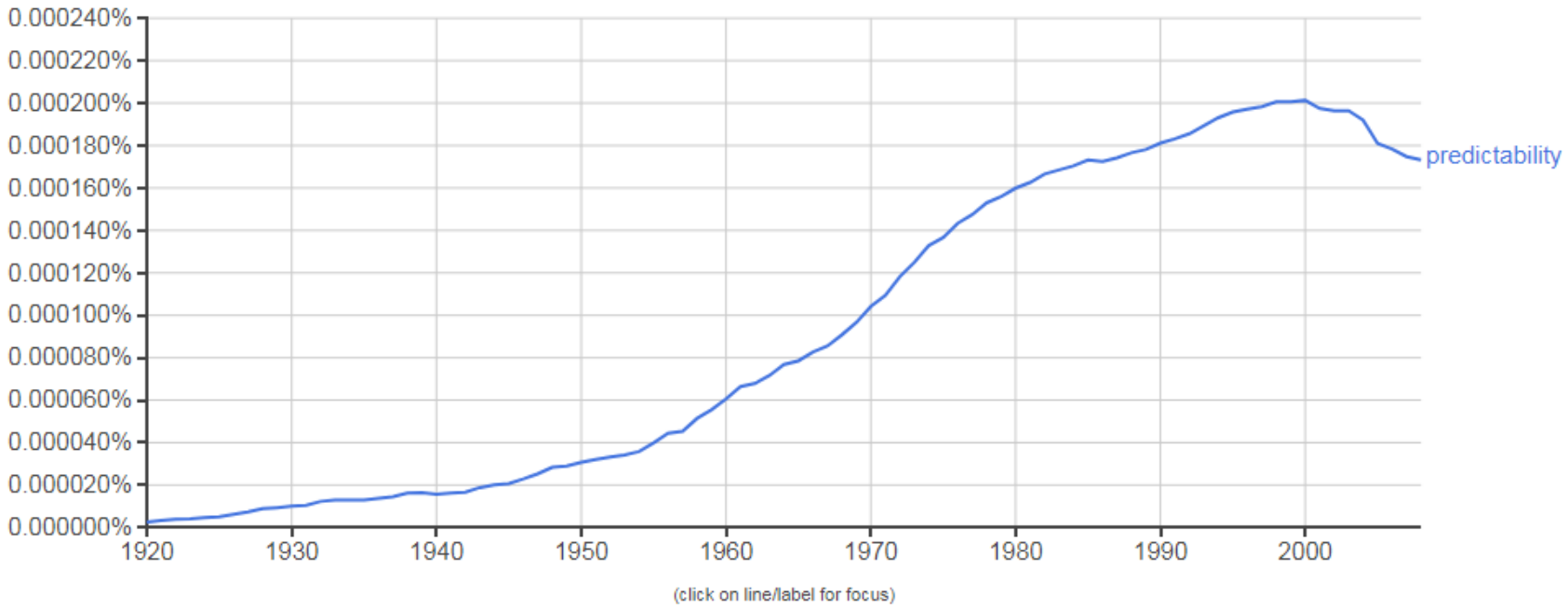
Operational Context: TBO

- TBO (**Trajectory-Based Operations**) approach – 4D trajectories (TTO/TTA)

- From tactical to strategical
    - ATCOs progressively assuming a monitoring role, instead of a tactical CDR role
- Overall traffic **predictability improvement as key driver** for improvements in:
    - Enhanced Safety due to reduction in controller workload
    - Increased airspace capacity due to a reduction in buffers
    - Cost reduction (fuel/time)
    - Reduction of Environmental impact (fuel, emissions, noise)
    - Better service provided
- With this as final goal, TP can already bring benefits in this direction by managing uncertainty and putting in place suitable models and techniques (**Engage TC2**)

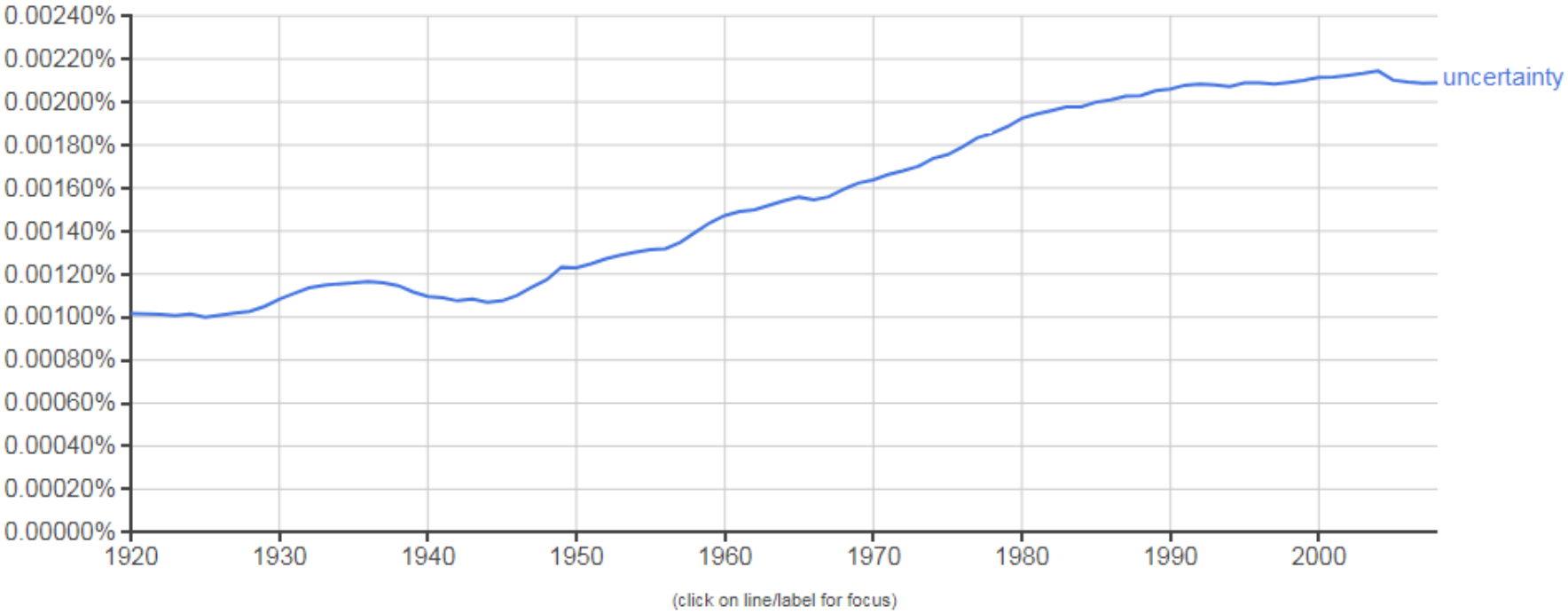
Some references: Predictability

Source: Google Books Ngram Viewer



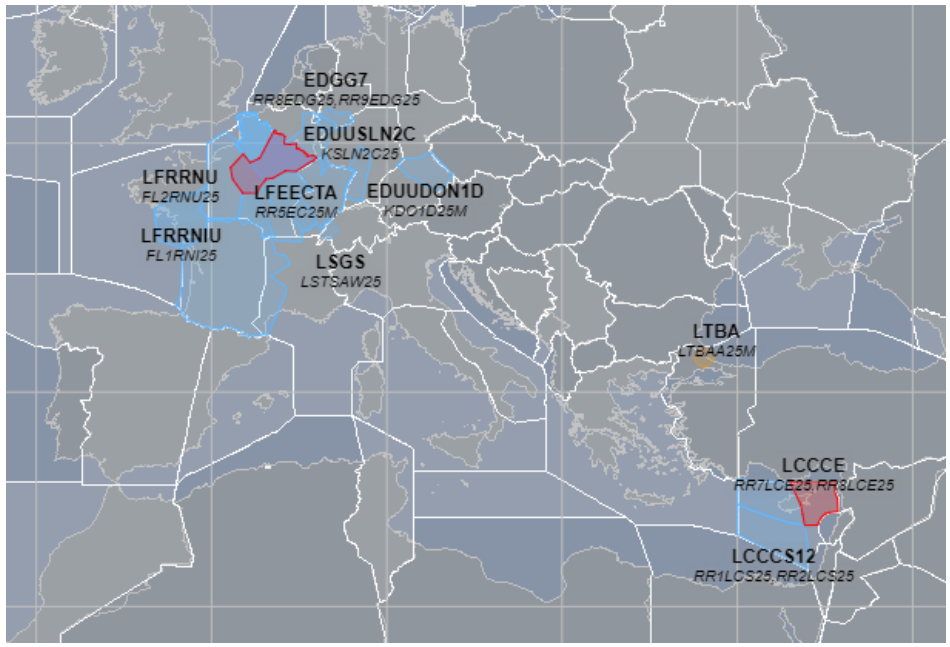
Some references: Uncertainty

Source: Google Books Ngram Viewer

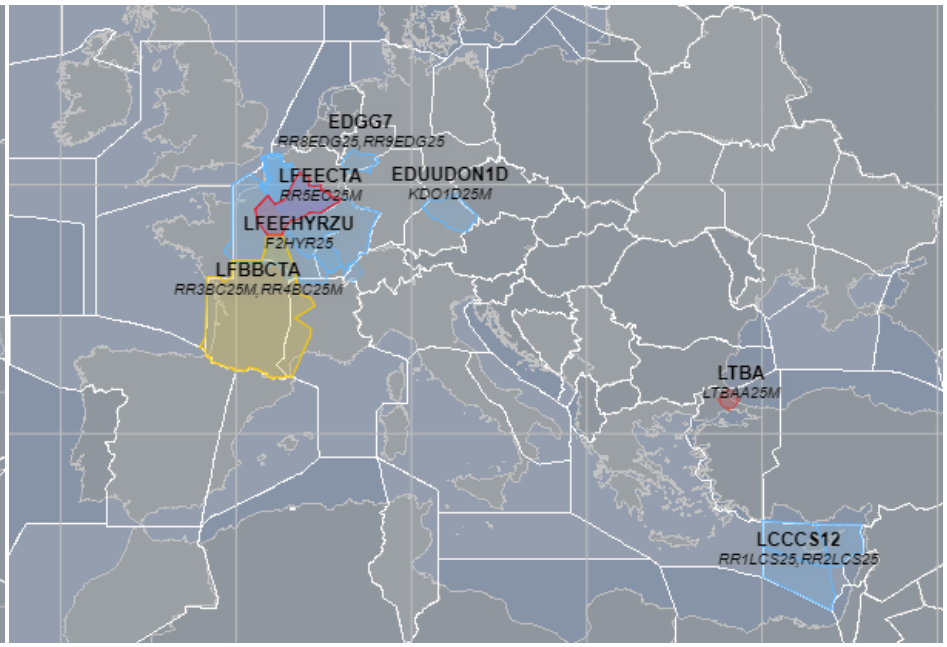


Uncertainty effects on Traffic

Forecast vs reality (from NOP; any given day)



Expected

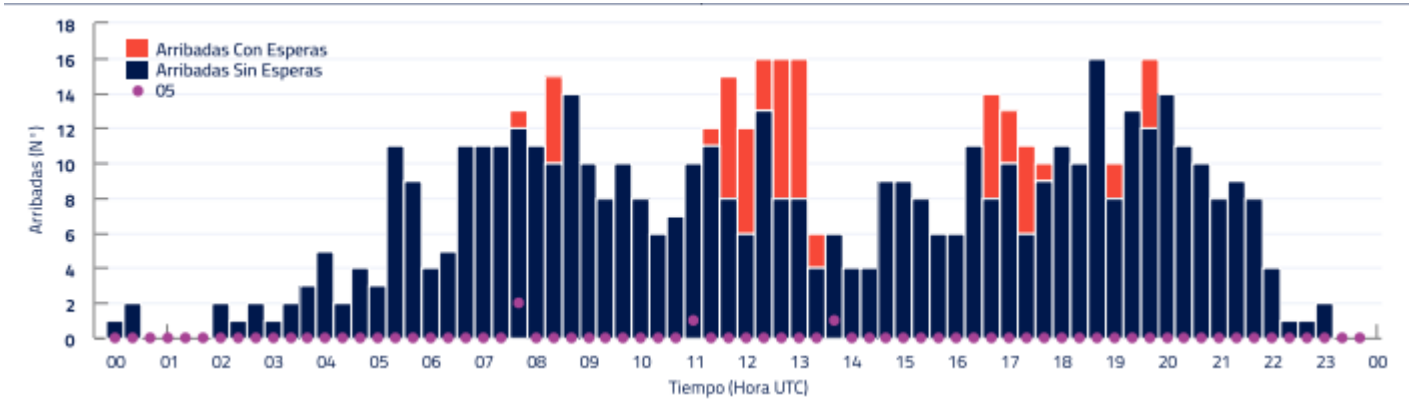


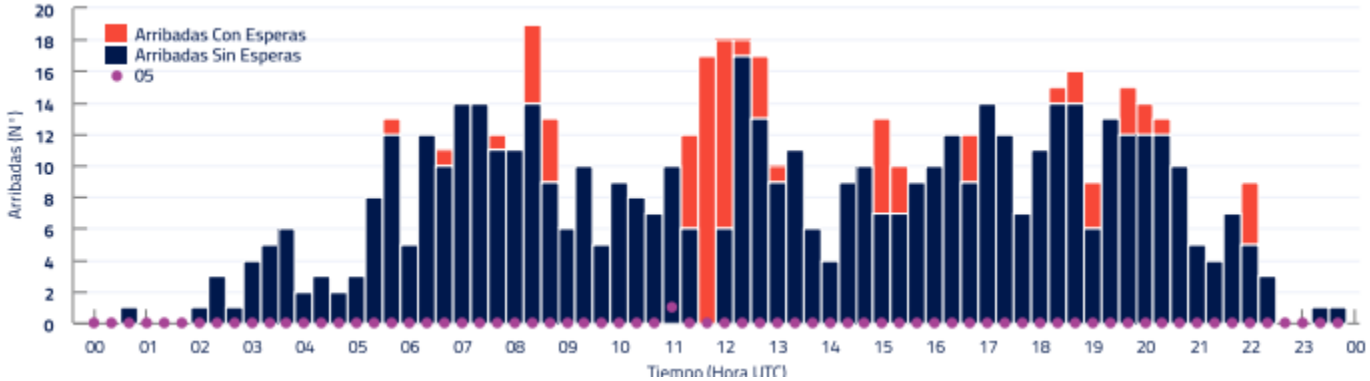
Observed

Are these patterns predictable?

Uncertainty effects on Traffic

Holdings (any given day)



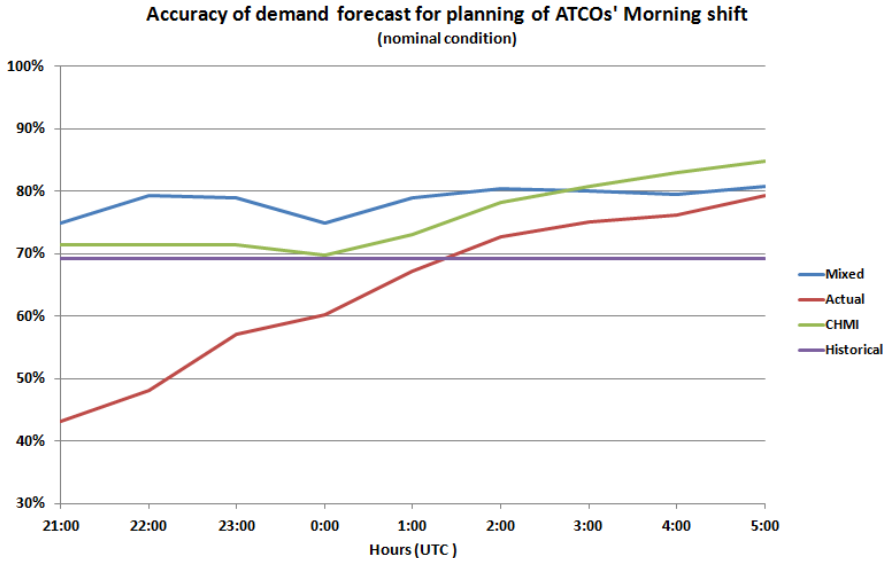


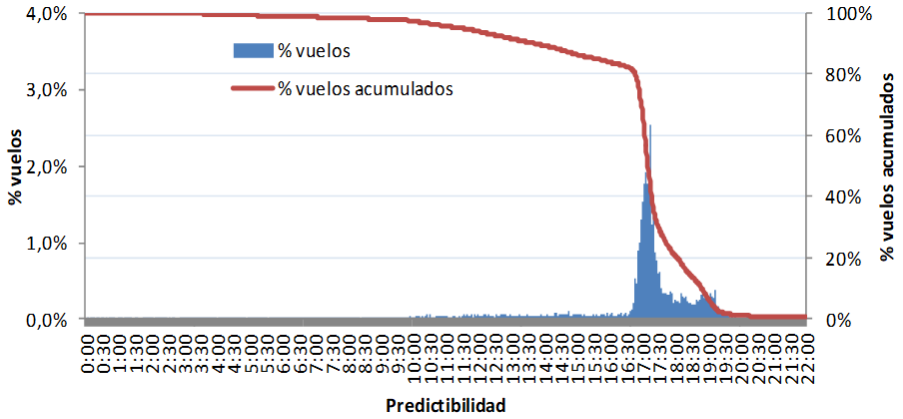
Are these patterns predictable?

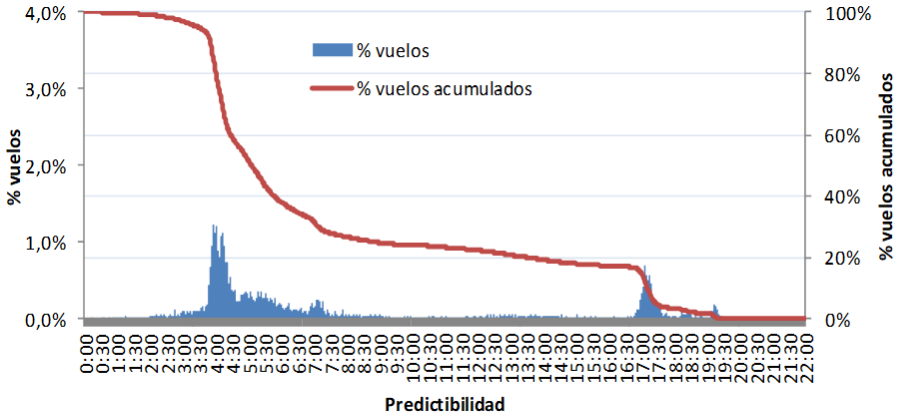
DIAPasON Foundations (I)

SESAR P04.07.07

in EXE-04.07.07-VP-006 run in Barcelona ACC. The implication is that different methodologies need to be used to develop the best TP for each AU.







DIAPasON Foundations (II)

SESAR ER COPTRA

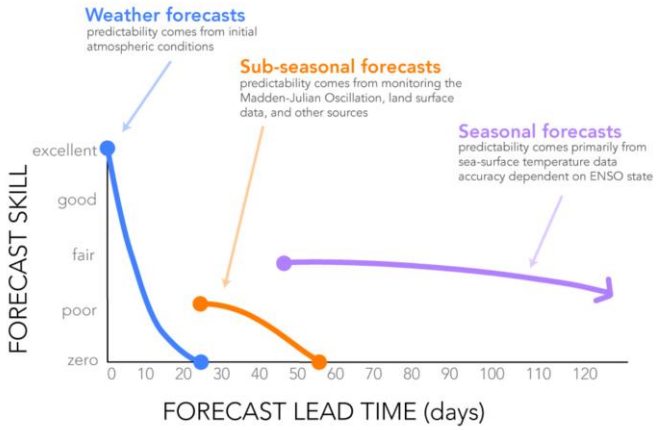
Combining Probable Trajectories - Uncertainty Management

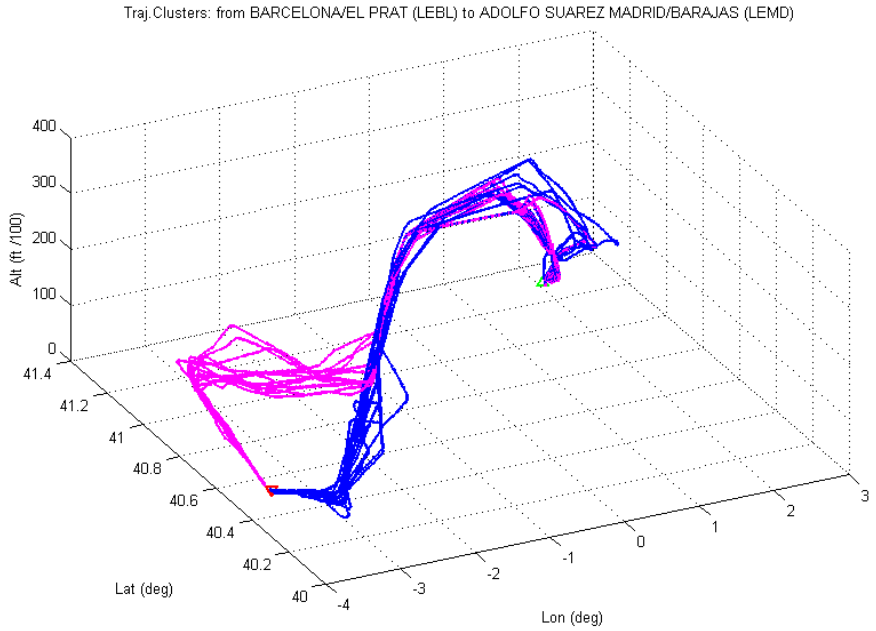
SESAR ER DART

Individual/Multiple TP (with optimisation)

H2020 Datacron

Predicting Moving entities discrete events





Research Structure

- **T1: Familiarisation and review of the state of the art**
- **T2: Sample Selection**
  - Defining criteria for sampling (availability in time & space)
  - No initial filtering
- **T3: Detection of Irregularities in Traffic (Non-nominal Traffic)**
  - Definition of non-nominal
  - Identification and isolation of irregularities (probability of occurrence)
  - Irregularities may vary per planning phase
- **T4: Traffic Clustering**
  - Study of clusters
  - Trajectory Clustering, Airline clustering, etc..
  - Clustering may vary per phase
- **T5: Predictive Methodology**
  - Identification of methodology
  - Study of techniques and tools
- **T6: Scenarios**
  - Predictive model constructed and applied in two different scenarios
  - High-resolution/Low-resolution
- **T7: Validation with Stakeholders**
  - Restricted F2F meetings

WBS

WP	Name	Tasks	Coordinator	Means of verification
WP 1	Data Sampling and Selection	T1-T4	CRIDA / ZenaByte	**Sample selected and traffic clustering completed**
WP 2	Analysis and Scenarios	T5-T6	ZenaByte / Deep Blue	**Model developed and scenarios established**
WP 3	Validation, Exploitation and Dissemination	T7	Deep Blue / CRIDA	**Data from validation obtained and disseminated**

Impact

- As extension of the work achieved in previous studies, its impact is focussed on **maturing exploratory research further towards applications and operational contexts**.
- In that sense, we plan to achieve a **maturity level of TRL 4 for the predictive models**. Hence, the basic principles and application of the methodology will be validated and reported through a case study and a practical exercise, demonstrating the benefits for the stakeholders.

- The **main contribution** of the DIAPasON project will be an **increase in the quality of trajectory prediction and traffic forecasting, adjusted to different planning horizons**.
- This will be achieved through the use of Machine Learning techniques to infer airspace users' behavioural drivers from historical data

Available raw data in DIAPasON

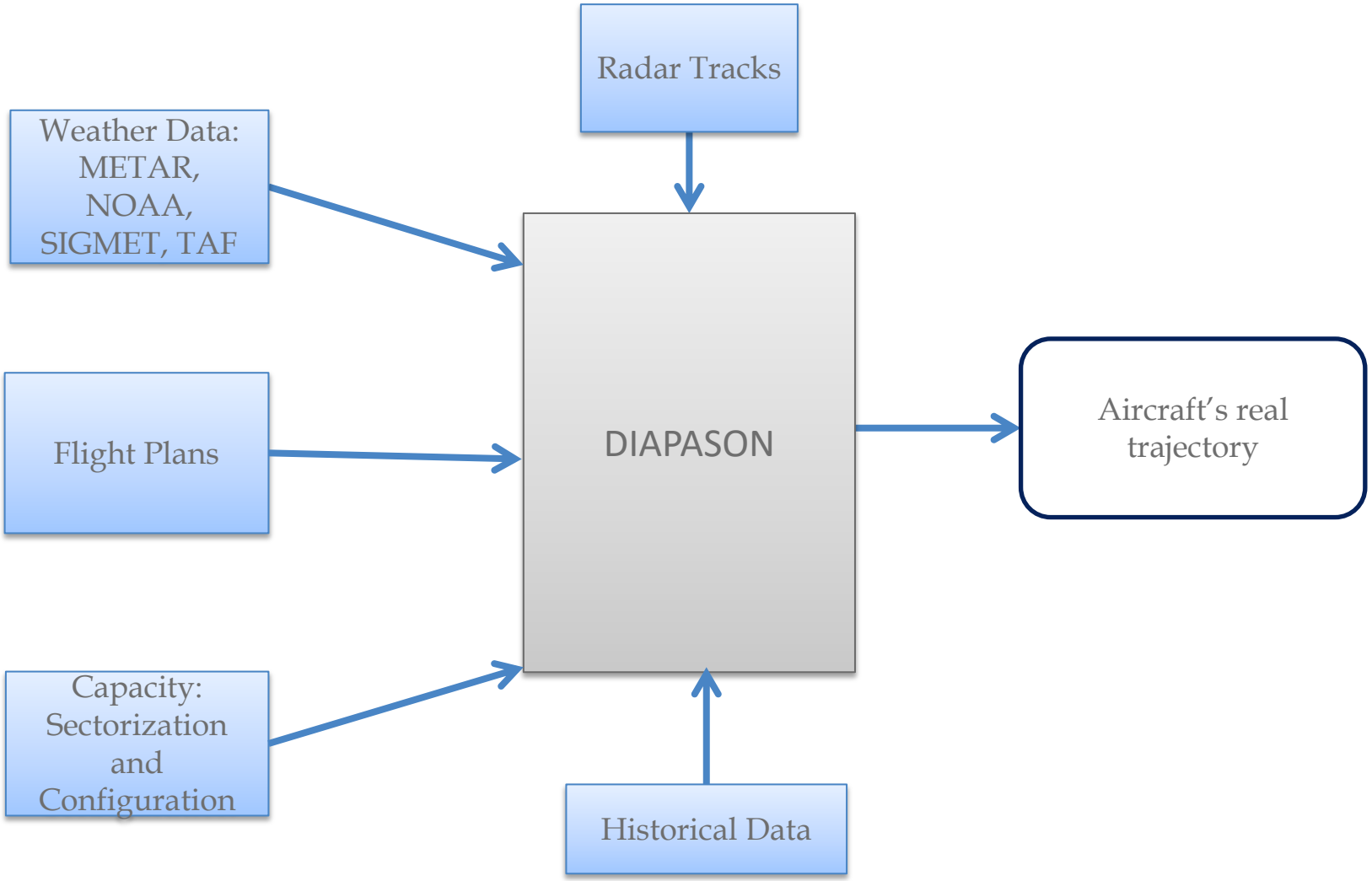
- **Surveillance Data**. Radar tracks of the Spanish airspace controlled by EnAire, the Spanish Air Navigation Service Provider (ANSP). Available from 2012 to 2019. For low-granularity scenario DDR is available from 2016 to 2019.

- **Weather Data**. Forecasts (downloaded from NOAA in grib format), Significant Meteorological Information (SIGMET), Meteorological Aerodrome Report (METAR) and Terminal Aerodrome Forecast (TAF).

- **Flight Plans**. Standard dataset generated by Airspace Users (AU) and agreed with the ANSPs, that represents an intended flight or portion of a flight. The FPs considered within DIAPasON are those stored in the Spanish ATC operational system, and include all flight plan amendments associated to the originally filed FP (GIPV from SACTA). For low-granularity scenario DDR is available from 2016 to 2019.

- **Airspace structure**. The airspace is organized in accordance with the envisioned traffic flown and the availability of resources to manage that traffic. Includes both possible and applied sector configurations. Available from 2012 to 2019. For low-granularity scenario DDR is available from 2016 to 2019.

Trajectory Prediction



Project Schedule

- Kick-off: 1st July 2019

Milestone number	Milestone name	Related WPs and tasks	Estimated date	Means of verification
M1	Intermediate Progress Report (IPR)	WP1/WP2 (T1-T6)	T0+6M	Metrics and scenario definition finished. Initial model appraised
M2	Final Progress Report (FPR)	WP2/WP3 (T1-T7)	T0+12M	Models and validation implemented. Data from test obtained. Exploitation and dissemination of results.
M3	Final Technical Report (FTR)	WP1-WP3 (T1-T7)	T0+12M	
M4	Dissemination and Exploitation Package (DEP)	WP3 (T7)	T0+12M	Project factsheet and infographic

Thank you very much for your attention!

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 783287

SESAR JOINT UNDERTAKING

Founding Members

EUROPEAN UNION EUROCONTROL