Validation of the Runway Utilisation concept

A case study for Vienna airport

9 th SESAR Innovation Days

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Outline

- Introduction & objectives
- Data & algorithm
- Case study
- Support tool
- Conclusions
- Recommendations

Introduction

This RTS is a V1 validation activity to investigate how the knowledge gained from the ML RU tool can be applied in the operational environment and support the tower runway controllers in their work. There were three main objectives of the RTS:

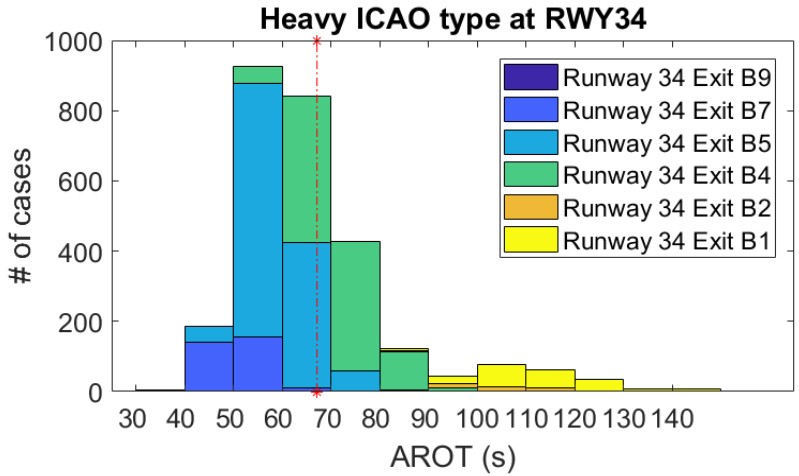
- **Operational Needs**
- **Operational feasibility & acceptability**
- **Controller requirements**

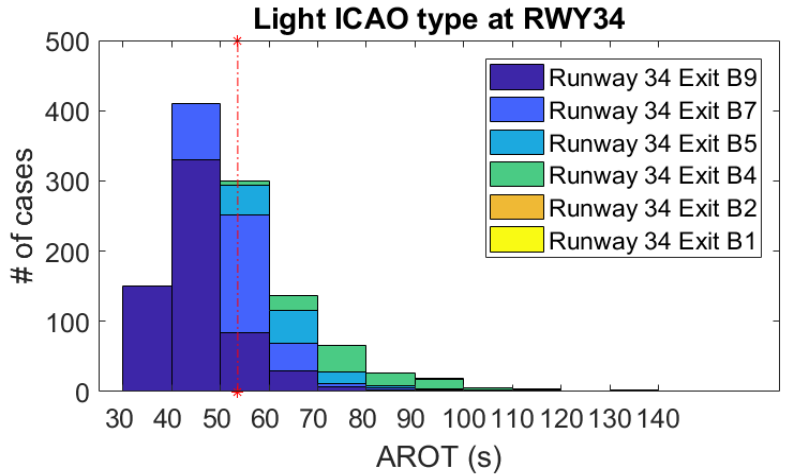
ML algorithm

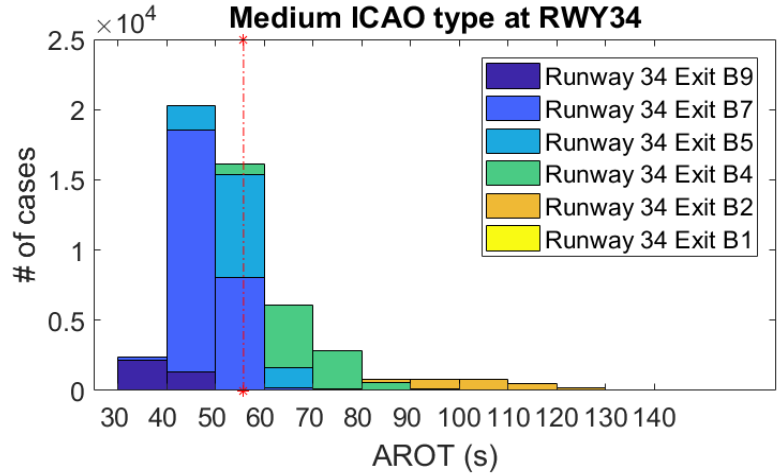
- An initial prototype controller support tool was developed to inform controllers in advance of the predicted Arrival Runway Occupancy Time (AROT) and/ or Runway Exit utilised (Nrex) for each aircraft, i.e. the ML RU controller support tool.

- Why the ML technique Gradient Boosting?

Data AROT and NREX







Radar, A-SMGCS, Wind profiler, SNOWTAM, SODAR and METAR data are extracted from runway schedulers and have been provided by VIE airport.

Solution description

- Within this study we are validating an algorithm that would support the tower ATCO during HIRO by making predictions relating to AROT and / or Nrex based on historical observations of runway traffic.

- The predictions are produced at 2NM upstream from the runway threshold.

- This enables tactical operational tools to be supplied with real time data and provide **additional information or warning to the tower controllers** if appropriate, based on these predictions.

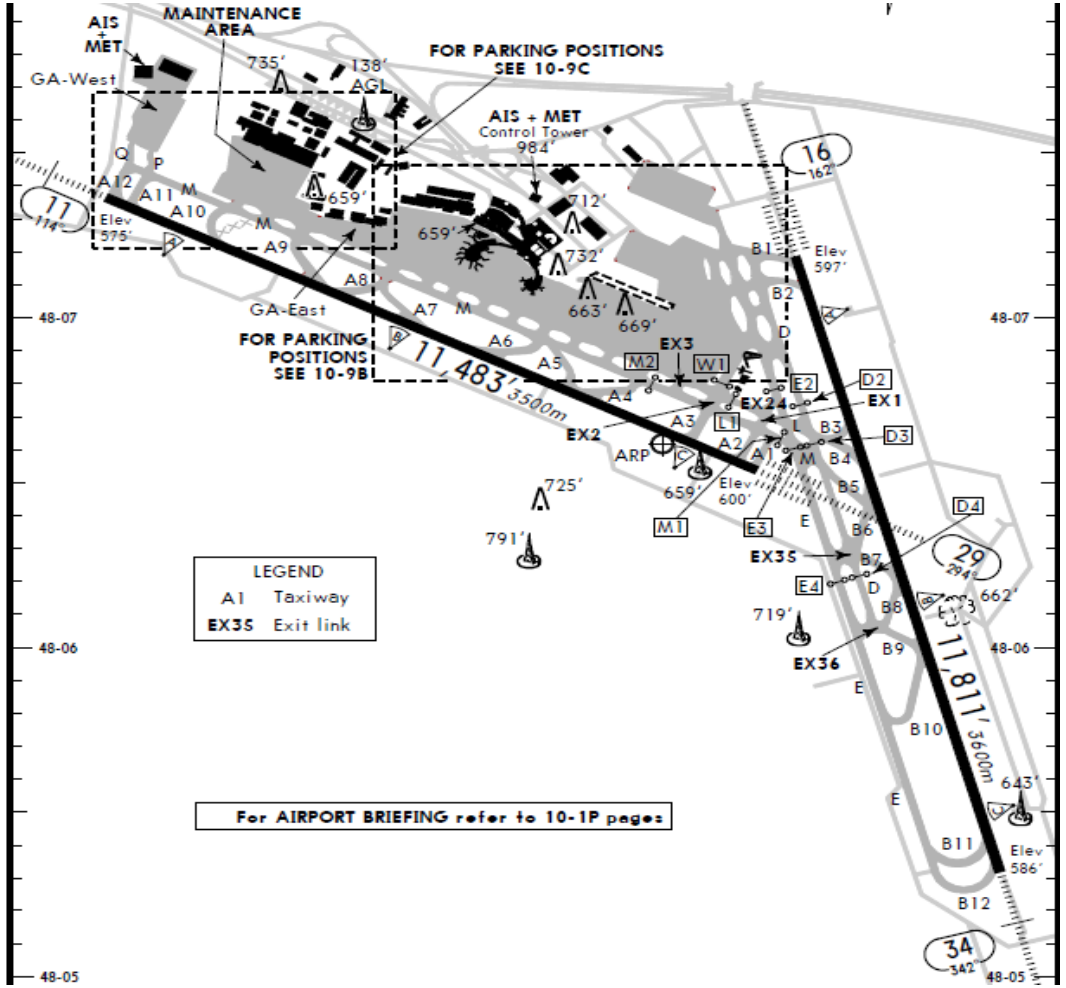
Solution description

- The RU ML support tool provides an indication on the tower runway controller CWP HMI of the likelihood that that the AROT of the landing aircraft will adhere to HIRO rules.

- A red indication will be provided when the prediction accuracy of AROT and/ or Nrex is lower than 80% during HIRO.

- A green indication will be provided when the prediction accuracy is higher or equal to 80%. The prediction will be produced at 2NM upstream from the runway threshold, enabling tactical operations tools to be fed and ATCOs to be warned about the two predictions identified above.

Case study RWY34



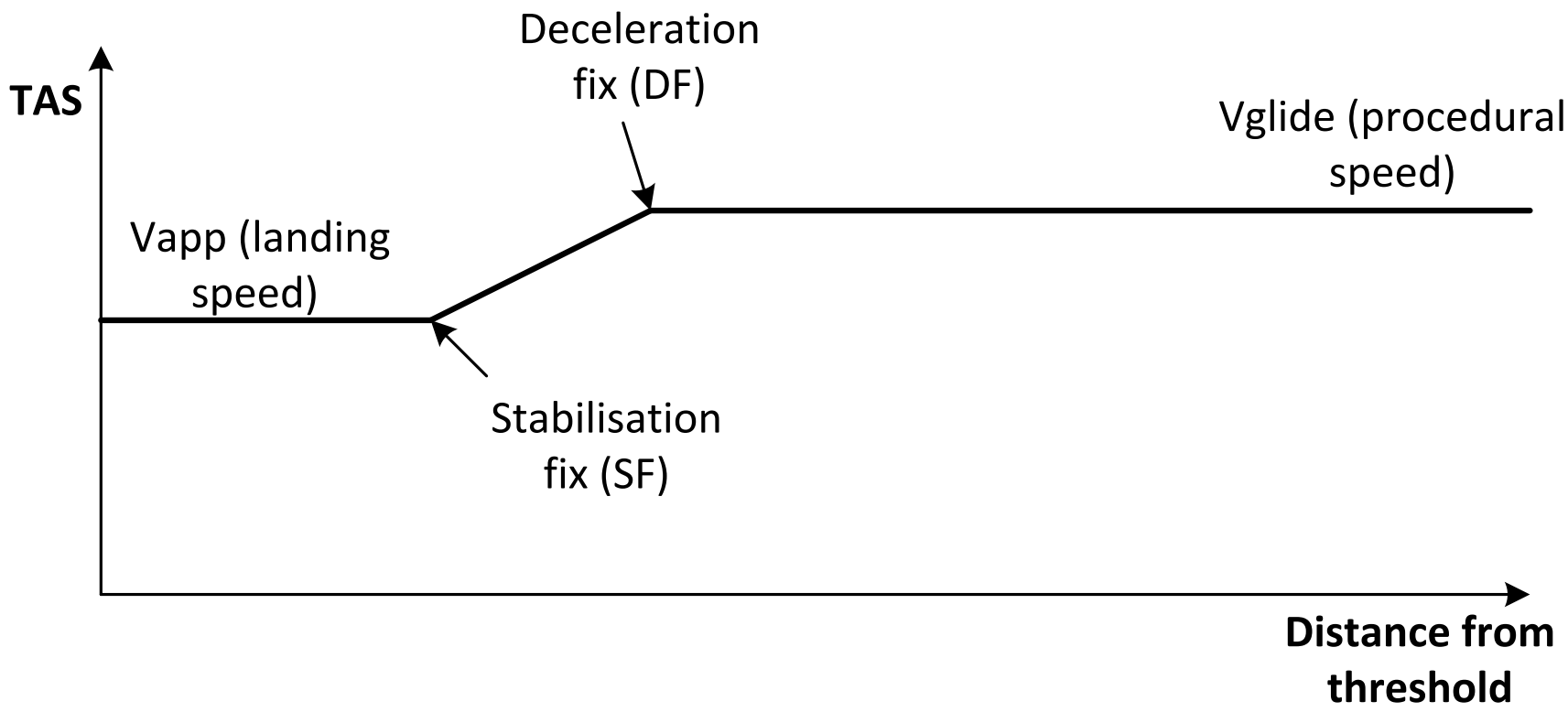
Traffic

ICAO WTC	RECAT LOWW WTC	Arr
A380-800	A380-800	1
Heavy	Heavy (except B76X/B75X/A310)	3
	B76X/B75X/A310	1
Medium	A320/B737NG	18
	Medium (except A320/B737NG)	16
Light	Light	2

Traffic

LEVEL Feet MSL	WIND HEADING	WIND SPEED Knots	WIND SPEED m/s	Crosswind Component Knots	Headwind Component Knots
000-4000	320	0	0	0	0
000-4000	320	20	10,28	6,8	18,8

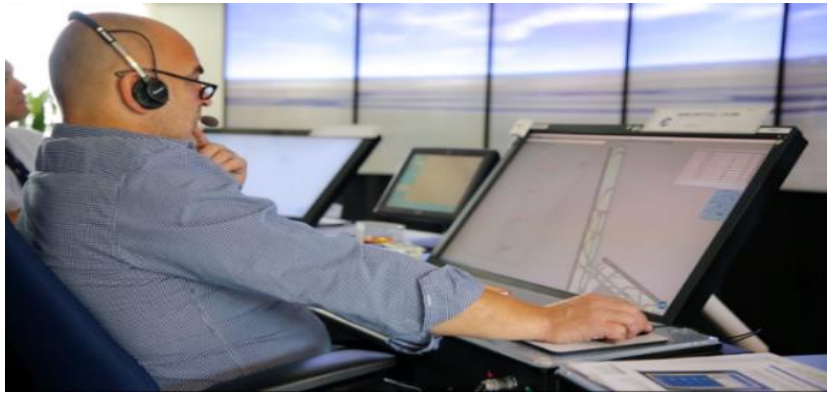
Traffic


TAS
Deceleration fix (DF)
Vglide (procedural speed)
Vapp (landing speed)
Stabilisation fix (SF)
Distance from threshold

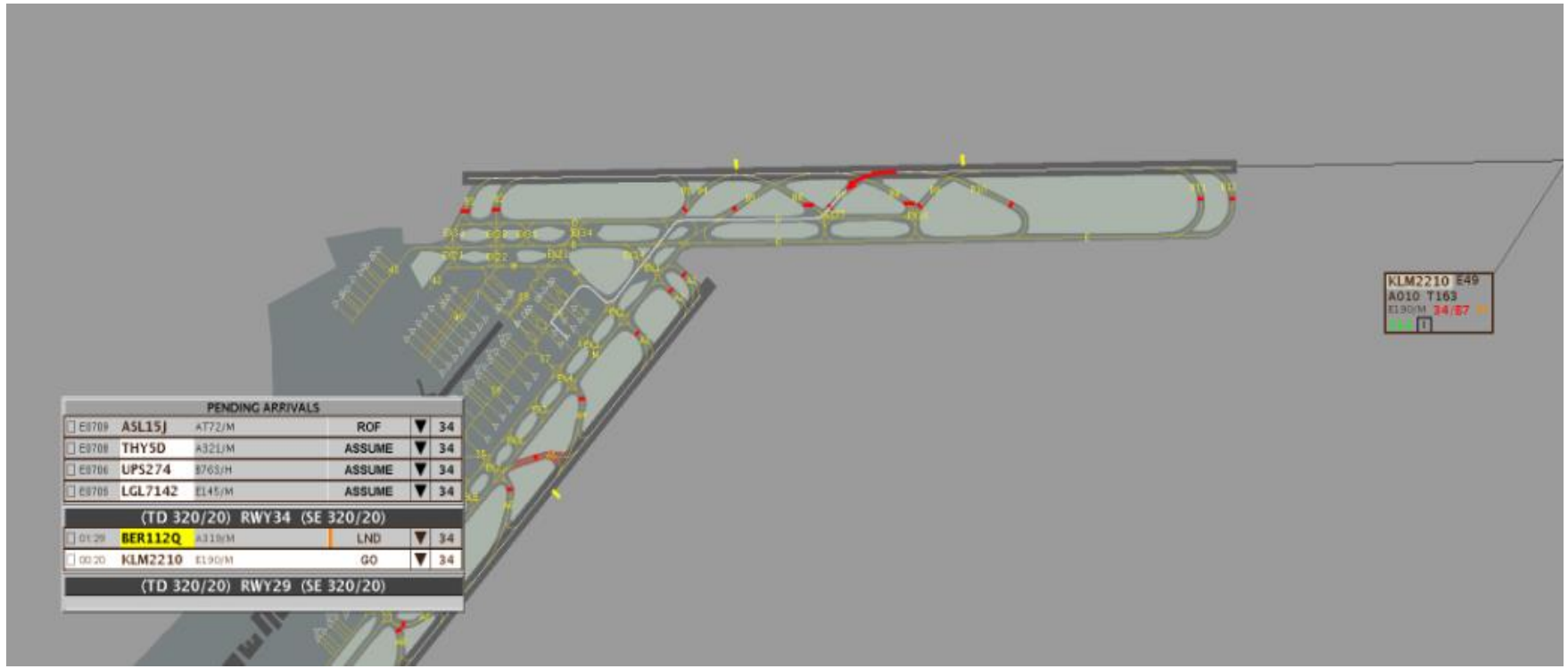
Simulation platform

The simulation was conducted using the EUROCONTROL RTS Early Demonstration & Evaluation Platform (eDEP) platform with integrated Tower Working Position (iTWP) and a 3D external view.

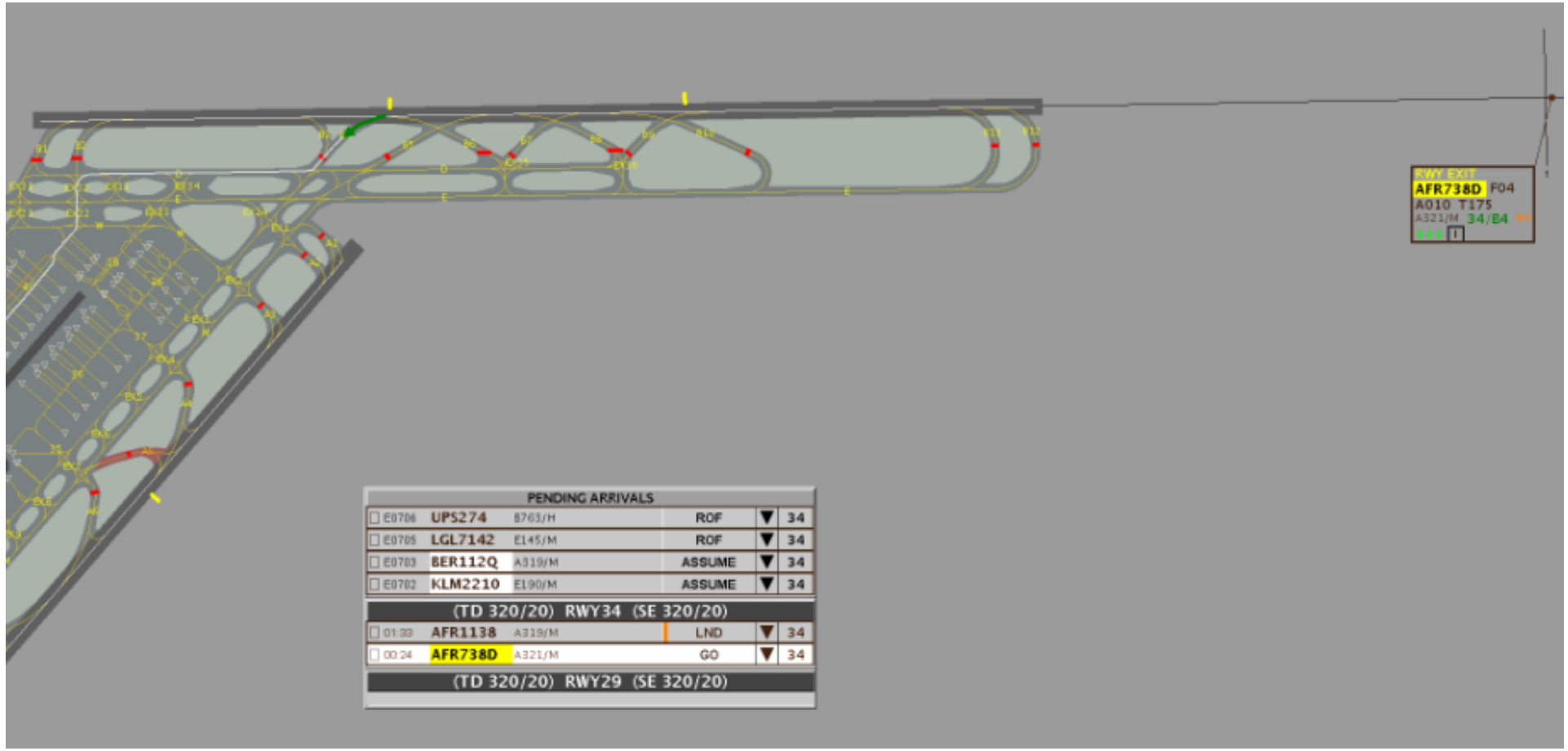
The RU ML support tool prototype for predicting AROT and Nrex was integrated into the EUROCONTROL eDEP iTWP.



Support tool – red arrow



Support tool – green arrow



Conduct of RTS

- The RTS took place over a 4-day period from 23rd to 26th May 2019. Two Vienna tower controllers participated in the RTS.

- Both controllers were already familiar with the eDEP iTWP simulation platform, as they had participated in several previous RTS conducted in SESAR1 WP6.8.1 and SESAR2020 PJ02, using the eDEP iTWP

Three different versions of the RU ML tool

- The initial prototype **RU ML support tool** with the Nrex prediction for an aircraft updated when the aircraft was at **2NM from the runway threshold**.

- The **RU ML support tool** with the Nrex prediction for an aircraft updated when the aircraft was **at runway threshold** (therefore the information was updated later but had a higher percentage accuracy/reliability than the information updated when the aircraft was at 2NM from the runway threshold (approx. 6% more accurate).

Three different versions of the RU ML tool

- The **RU ML support tool** with the Nrex prediction for an aircraft updated when the aircraft was **at 2NM** from the runway threshold **plus an automatic pop-up information alert** displayed on the iTWP HMI when an aircraft was predicted to take a non-procedural runway exit (i.e. with a less than 80% prediction of taking the assigned/procedural runway exit as defined in the AIP) that would increase the AROT to above what was usual for that aircraft type.

Some conclusions from Vienna ATCO

- The controllers concluded that certain predicted information based on ML, such as AROT, could be used to support operations and controllers work by enhancing controllers' situation awareness and hence provide potential safety benefits.

- Based on the findings from the V1 validation activity we can conclude that the V1 maturity has been completed, as the ML RU tool was reported to meet controllers' operational needs and provide some safety benefits.

Some conclusions from Vienna ATCO

- ML RU controller support tool for AROT was considered operationally feasible and acceptable to the Vienna controllers that took part in the simulation. Predicted runway exit utilised information based on ML was also considered to be operationally feasible and acceptable by one of the Vienna controllers but was seen as something that would be a ‘nice to have’ option.

Recommendations

- Three potential solutions were identified for a ML RU controller support tool for AROT predictions and proposed for further investigation in V2:
  - A **simple solution** for segregated runway modes only. This solution would consist of an automatic pop-up information alert when there may be a potential issue e.g. the AROT of the preceding aircraft is greater than the average due to, for example, a non-procedural runway exit further up the runway.
  - An **intermediate solution** for mixed mode runway operations. This solution would consist of an automatic pop-up information alert as defined in the simple solution above **plus** the predicted AROT.

Recommendations

- An **advanced solution**. The advanced solution would consist of the predicted AROT determined by the ML being integrated into the ORD tool In an advanced solution with an ORD tool as developed in SESAR 2020 PJ02-01 input the AROT determined by the ML into the FTD chevron when lead a/c is at 1.5NM - 2NM from the runway threshold.

Thank you!