Machine Learning Predictions in Real-Time Airport Operations

Prague Airport

Vladimír Kuráň

Prague Airport

Contents

- Context
- Machine learning model
- Live ops

Context – aimed solution

Operational need for

- Stable departure sequence
- Improved turnaround predictability
- Improved on-time performance
- Lower ground handling workload
- Proactive resource allocation

Required solution characteristics

- Principles of digitalization and automation
- Data driven approach
- A-CDM compliant
- Conformity with future AOP
- Compliant with previous research

Context - A-CDM

Airport Collaborative Decision Making (A-CDM)

- Aims to optimise airport operations through real-time information sharing and coordinated decision-making among all stakeholders
- A-CDM provides overall situational awareness by monitoring important timestamps (milestones) during ground handling activities
- Target Off-Block Time (TOBT) is the expected time when an aircraft will be ready for departure (essential milestone)

Shortcomings of current TOBT input

- Deficiencies caused by manual input of TOBT
- Confidence in optimistic scenarios leading to last-minute changes of TOBT value
- Minor TOBT refinements cause perpetual departure sequence re-calculation

Machine learning model - development

SESAR 2020 – PJ04-W2-28.2 LiteAPOC

- Concept validation – real-time simulation using simplified autoTOBT
- Recommendations: Need for user's trust

Eurocontrol EATIN – project OpTT 1.0

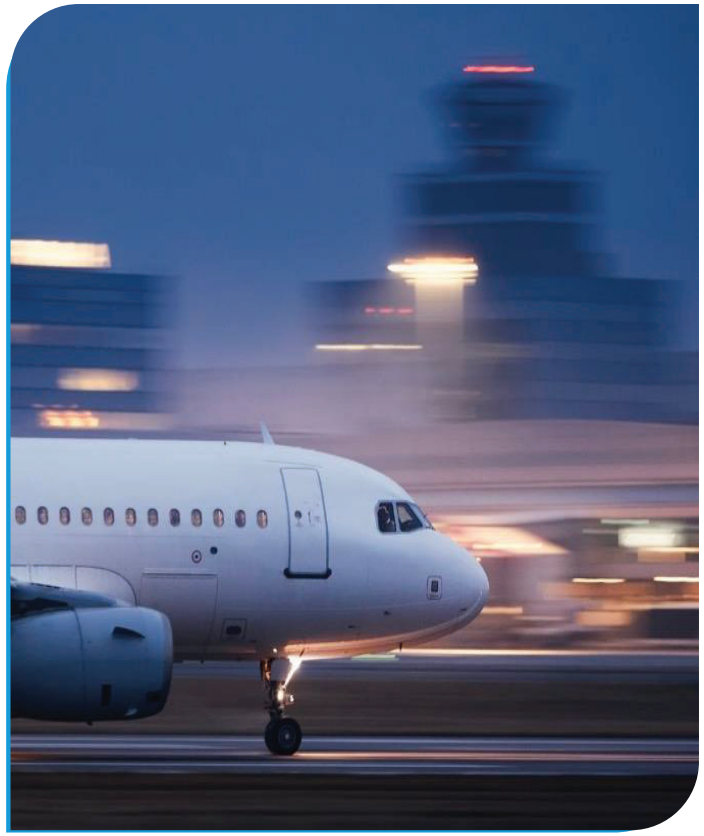
- ML model development
- Generalization of the model

LKPR live trial

- 07/2023 – 03/2024 TOBT = EOBT for GA/BA flights

LKPR live ops

- Starting 26.03.2024



Machine learning model - development

Goal: provide prediction of Target Off-Block Time (POBT)

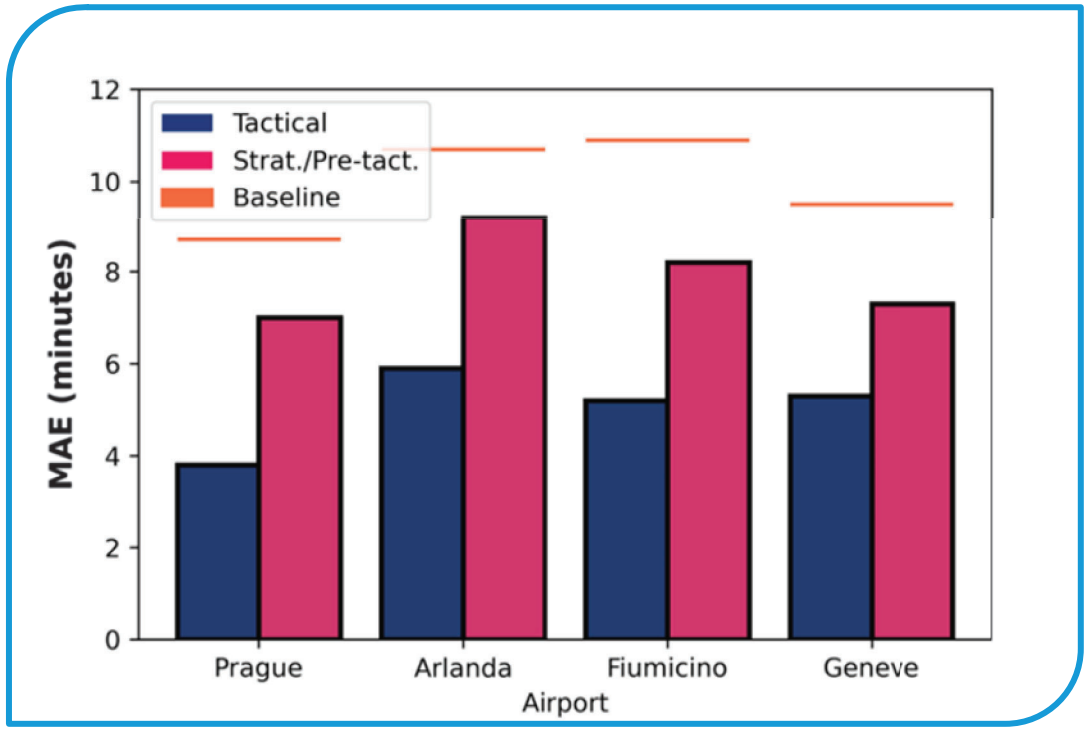
- ML model refined to 10 key inputs
- Modelled typical turnaround occurrences envisaging human-in-the-loop adjustments
- Available turnaround time: SOBT – EIBT allowing dynamic updates
- Results of ML model as one of decisive factors for POBT

Statistical evaluation → Simulation → Perfection → Proof of robustness → Localization → Shadow mode → Live ops

Machine Learning model – OpTT1.0 evaluation

- Model generalization: a single model providing predictions for all four airports
- Identical results to single models
- OpTT2.0 project focusing on predictions of TOBT and turnaround duration for all CDM airports
- 68% of predictions every day would not need any update at the network level

$$MAE = \frac{1}{n}\sum_{i=1}^{n}\left|TOBT_{final} - TOBT_{predicted}\right|$$



Mean Absolute Error values. Model performance for the four airports measured at AIBT

Live operations - Staff training

Need to build trust for new counterintuitive tool

- Intensive workshops for all GHA agents
- Thorough explanation of the background algorithm
- New assisting features in A-CDM operational GUI

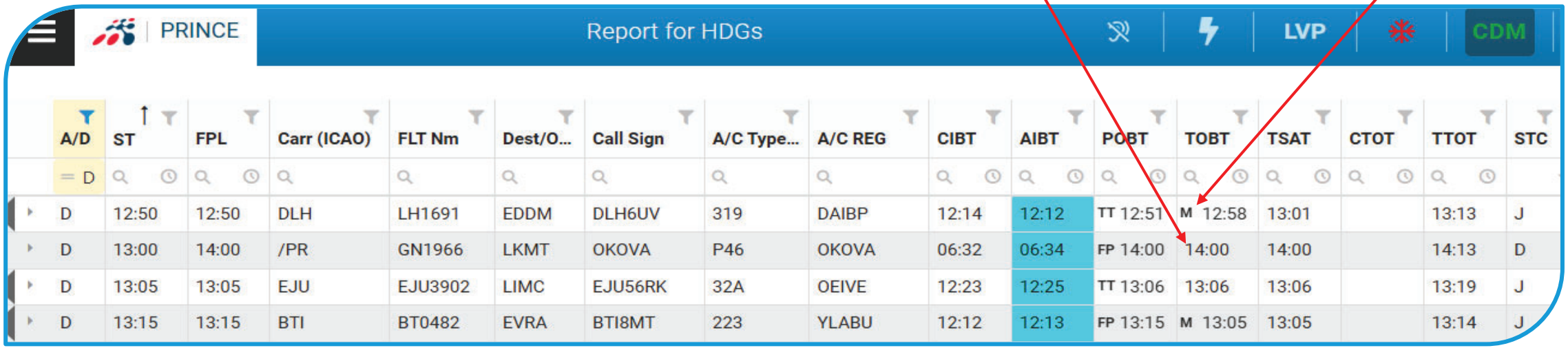
  alerts, notifications, hints

	Before	Now
Turnaround defined by	fixed value	predicted value
TOBT input	manual	automatic
Motto	“WE **HAVE TO** MAKE IT IN 40 MINUTES OR LESS“	“WE **TYPICALLY** MAKE IT IN 46 MINUTES“

Live operations - Integration to operational systems

Establishing Target Off-block Time

1. ML model calculates predicted turnaround time
2. Algorithm processes decisive factors and Predicted off-block time is determined
3. Ground handling evaluates Predicted Off Block Time value
   - POBT is compliant with observed handling process → **automatic TOBT is generated and shared**
   - GH agent has additional information → manual override employed, **TOBT is set manually**



A/D	ST	FPL	Carr (ICAO)	FLT Nm	Dest/O...	Call Sign	A/C Type...	A/C REG	CIBT	AIBT	POBT	TOBT	TSAT	CTOT	TTOT	STC
= D																
D	12:50	12:50	DLH	LH1691	EDDM	DLH6UV	319	DAIBP	12:14	12:12	TT 12:51	M 12:58	13:01		13:13	J
D	13:00	14:00	/PR	GN1966	LKMT	OKOVA	P46	OKOVA	06:32	06:34	FP 14:00	14:00	14:00		14:13	D
D	13:05	13:05	EJU	EJU3902	LIMC	EJU56RK	32A	OEIVE	12:23	12:25	TT 13:06	13:06	13:06		13:19	J
D	13:15	13:15	BTI	BT0482	EVRA	BTI8MT	223	YLABU	12:12	12:13	FP 13:15	M 13:05	13:05		13:14	J

Live operations - Statistics

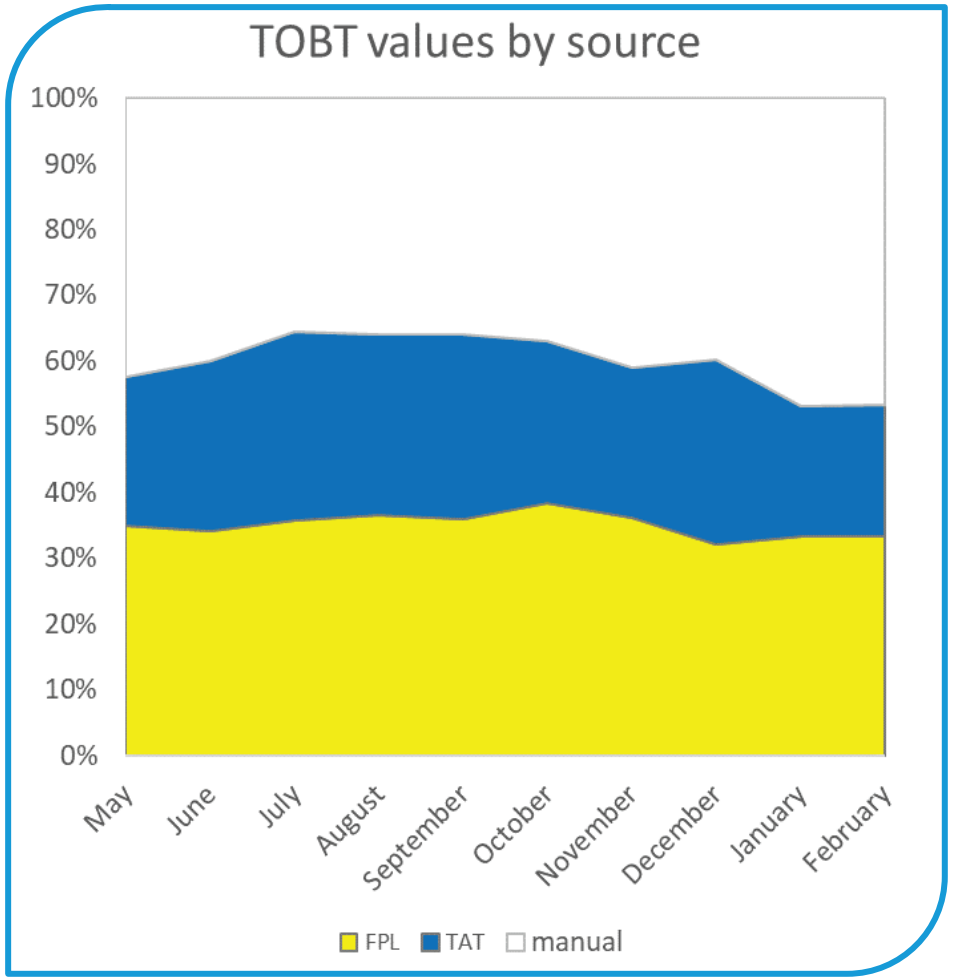
Auto TOBT live from 26.03.2024

TOBT Statistics

Manual	app 40%
Automatic	app 60%

Automatic prediction of TOBT

Flight plan	on average 63%
Turnaround	on average 37%



Live operations – Lessons learned

- **Knowledge** – all stakeholders must understand underlying principle → **education**
- **Precision** – all stakeholders shall distinguish between wanted and realistic values → **education**
- **Trust** – takes time to gain → **education**
- **Change management** – small consecutive steps helpful → **education**
- **Sustainability** – regular refreshing training needed → **never ending process**
- **Adaptation** – fine tuning of the algorithm according to the operational needs → **never ending process**

Q & A