A(I)MAN: Machine Learning for Arrival Management

Frank Zetsche

Head of Simulation and Research

DFS, German Air Navigation Services

FlyAI Forum

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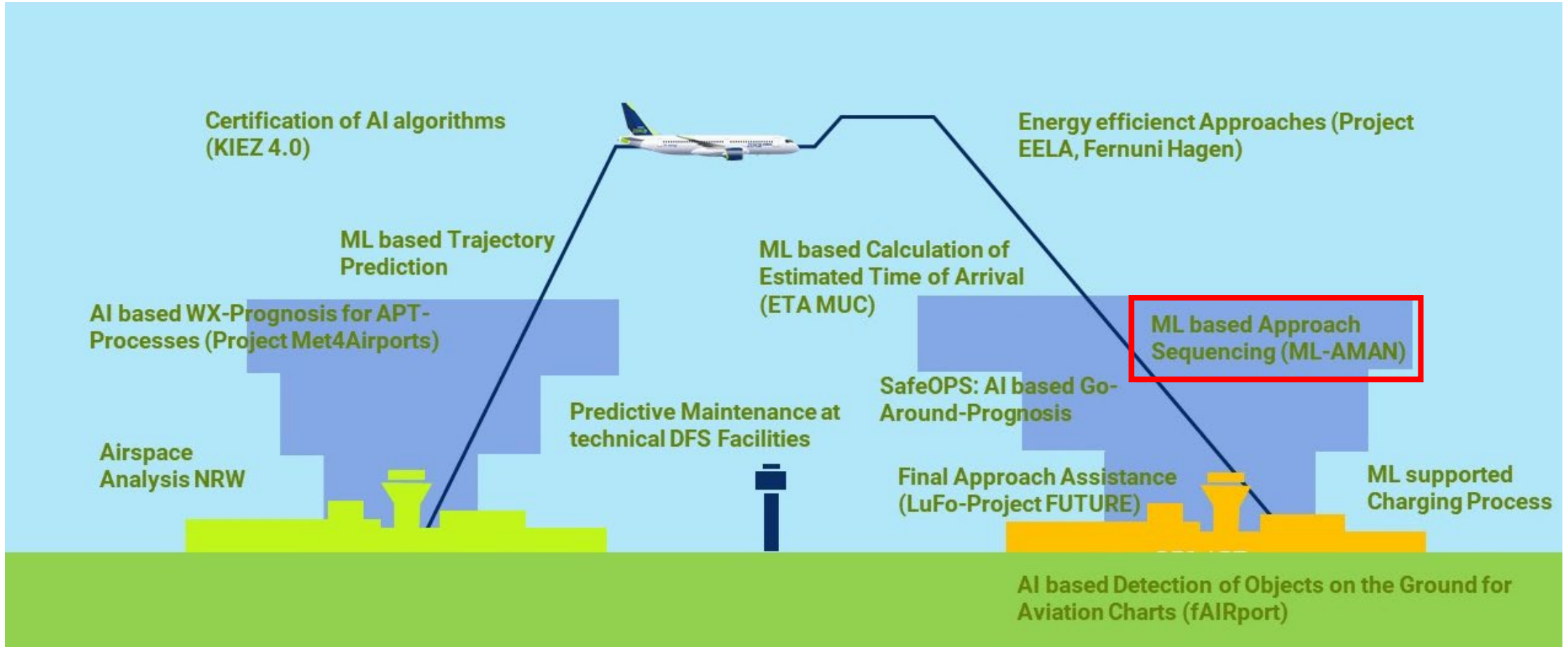
DFS Deutsche Flugsicherung

Overview of AI Solutions for Air Traffic Services



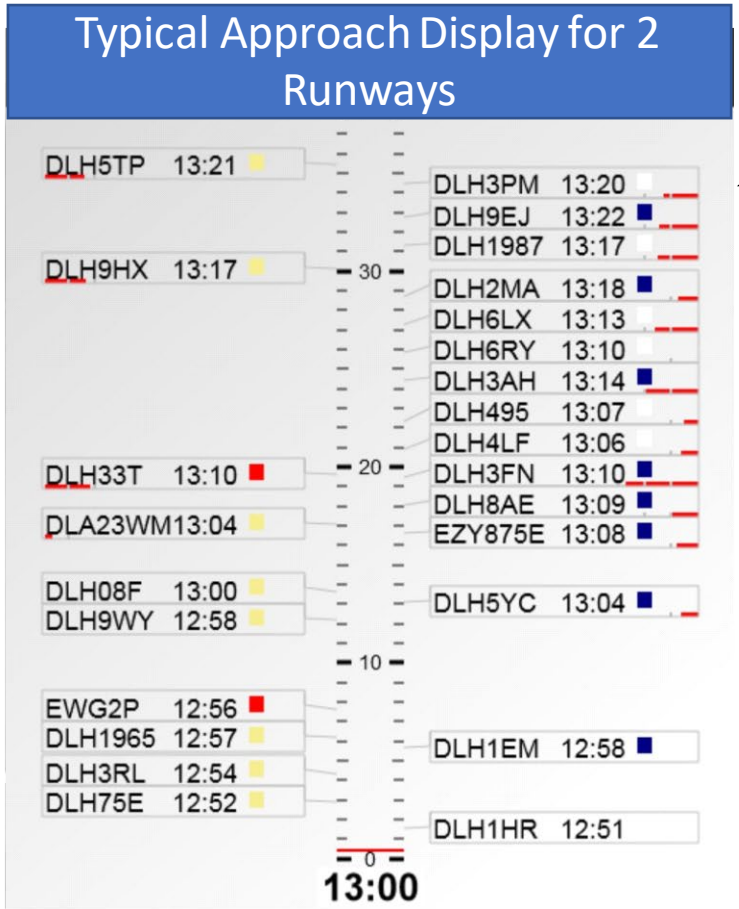
Arrival Manager Functions

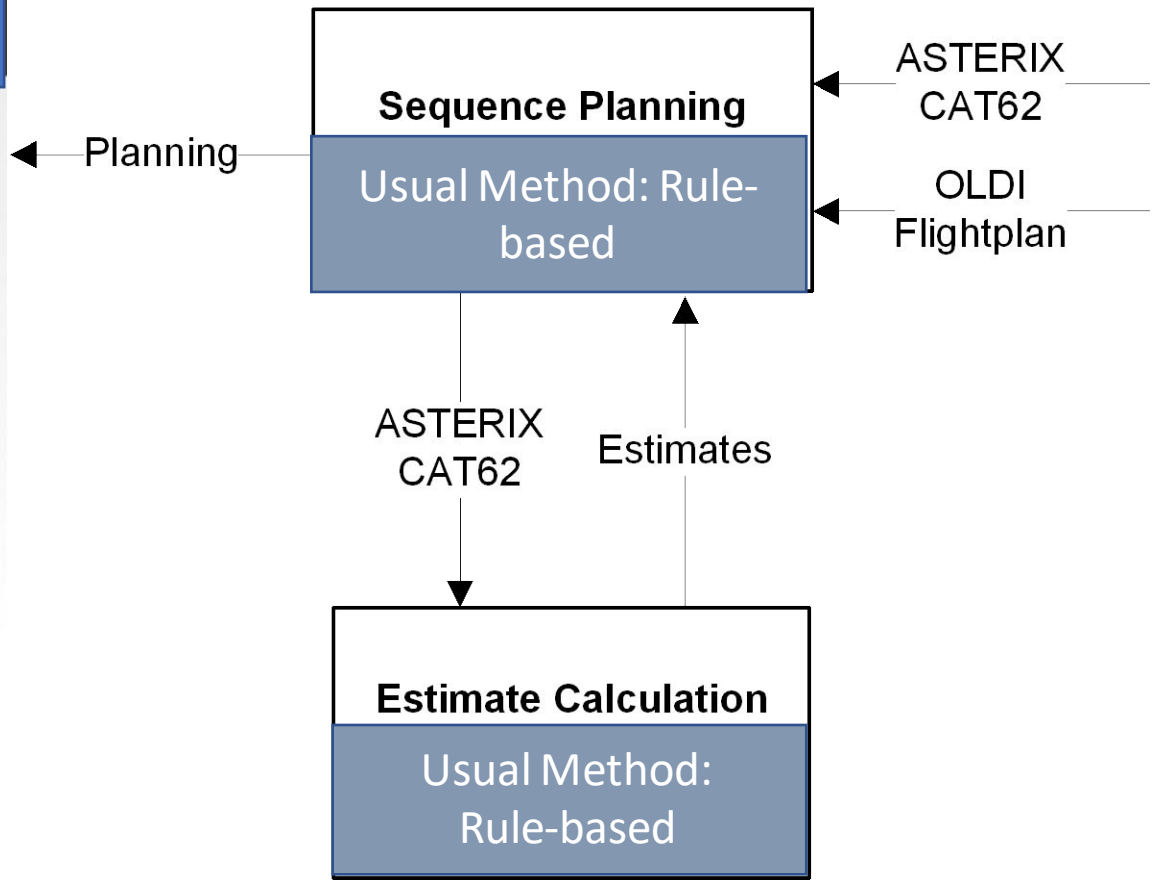
The Arrival Manager (AMAN) assists the Air Traffic Controller in arrival planning und execution.

The AMAN main functions are

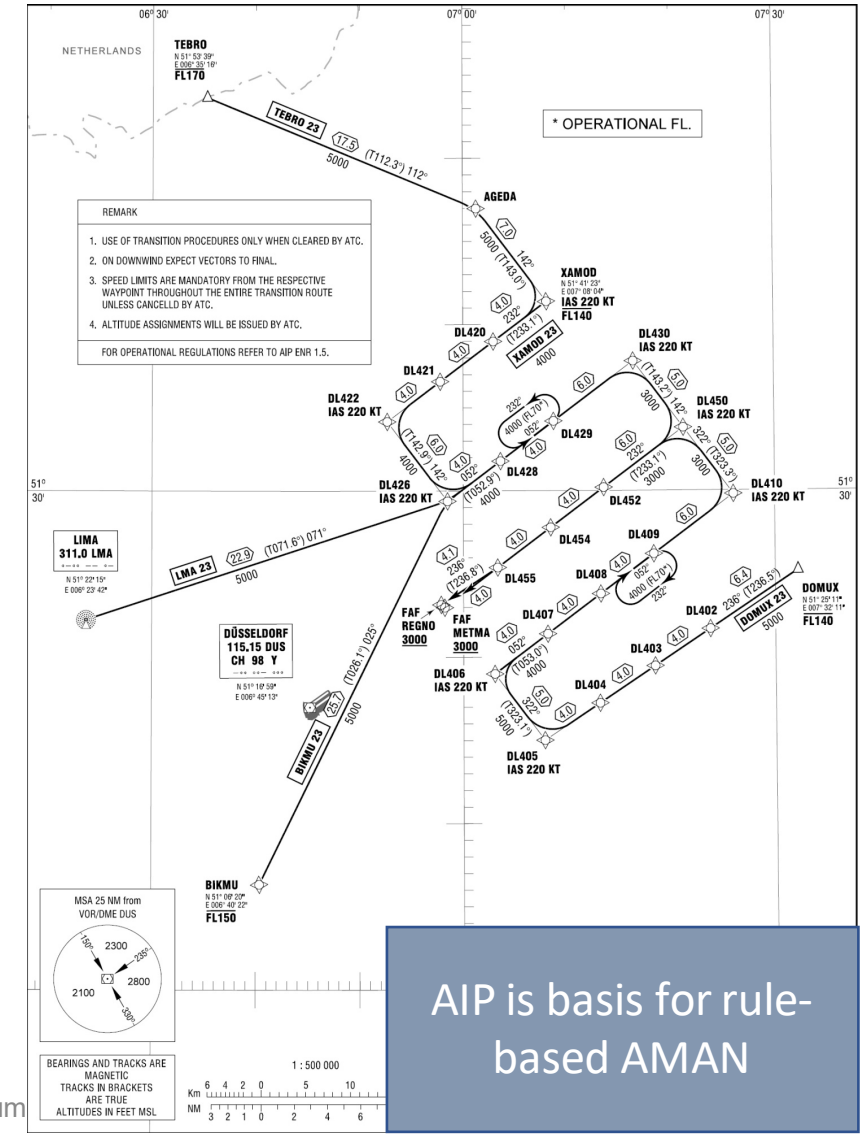
- Sequence planning
- Estimate calculation

DFS uses an “adaptive”, iterative, computation.

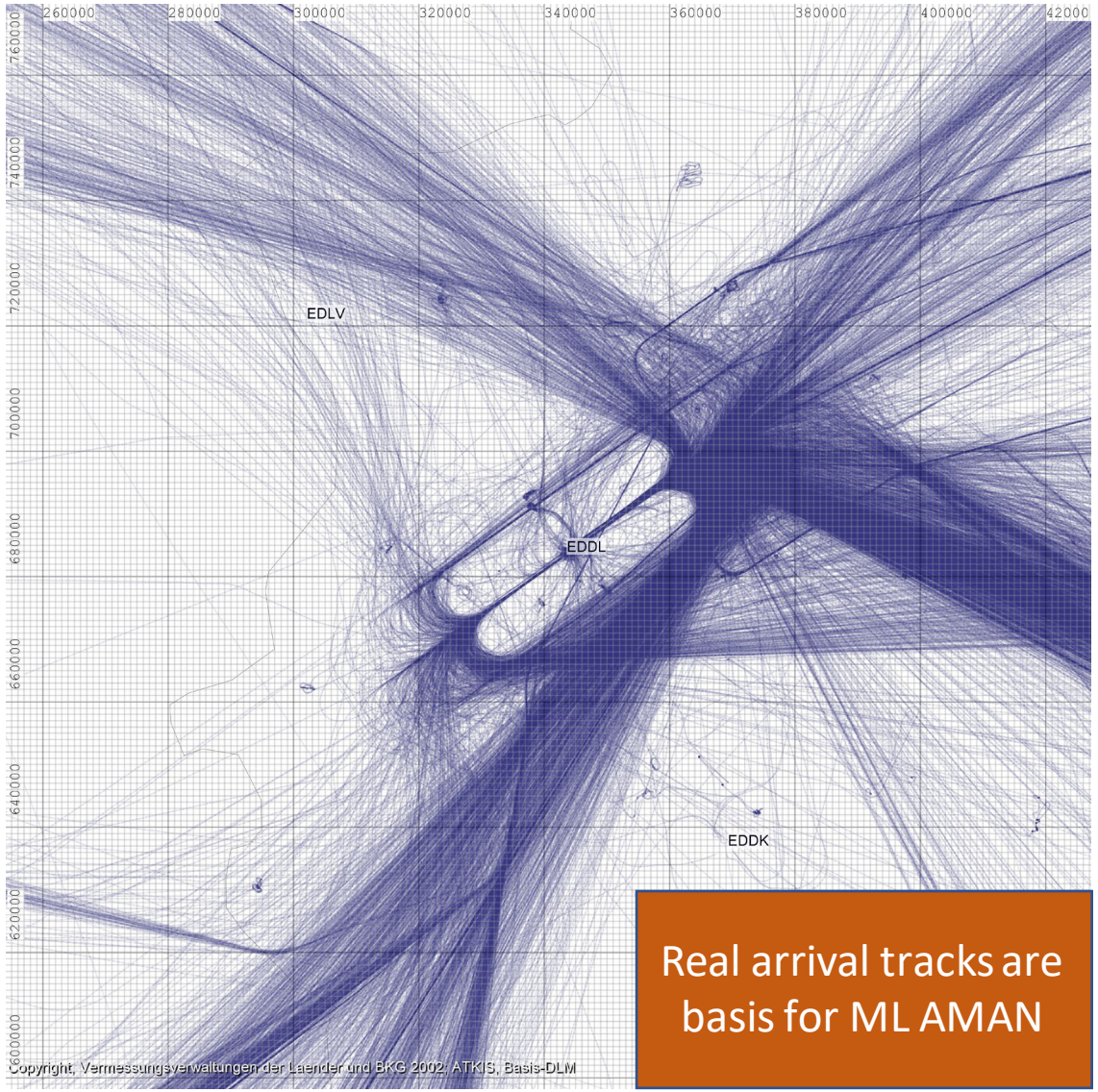




Arrival Chart and Arrival Tracks for Duesseldorf Airport



AIP is basis for rule-based AMAN



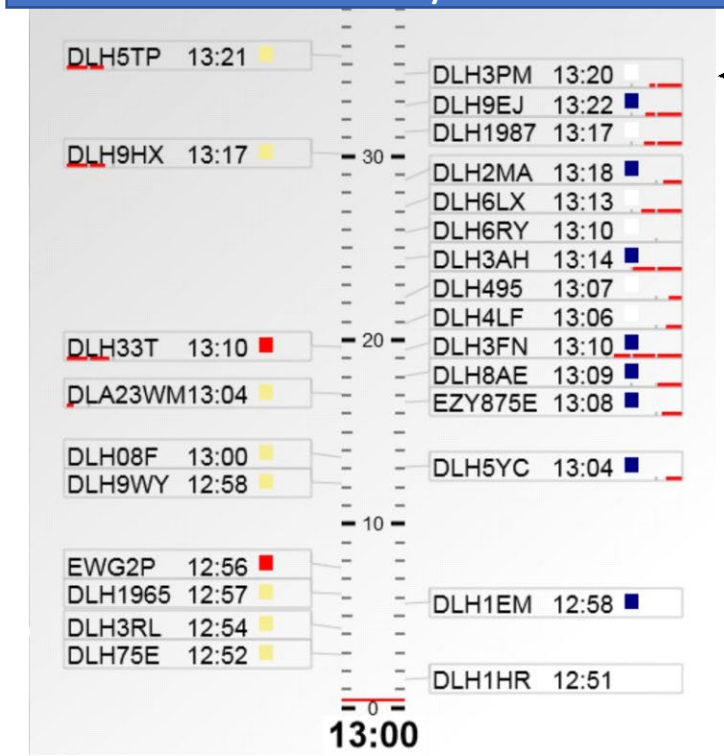
Real arrival tracks are basis for ML AMAN

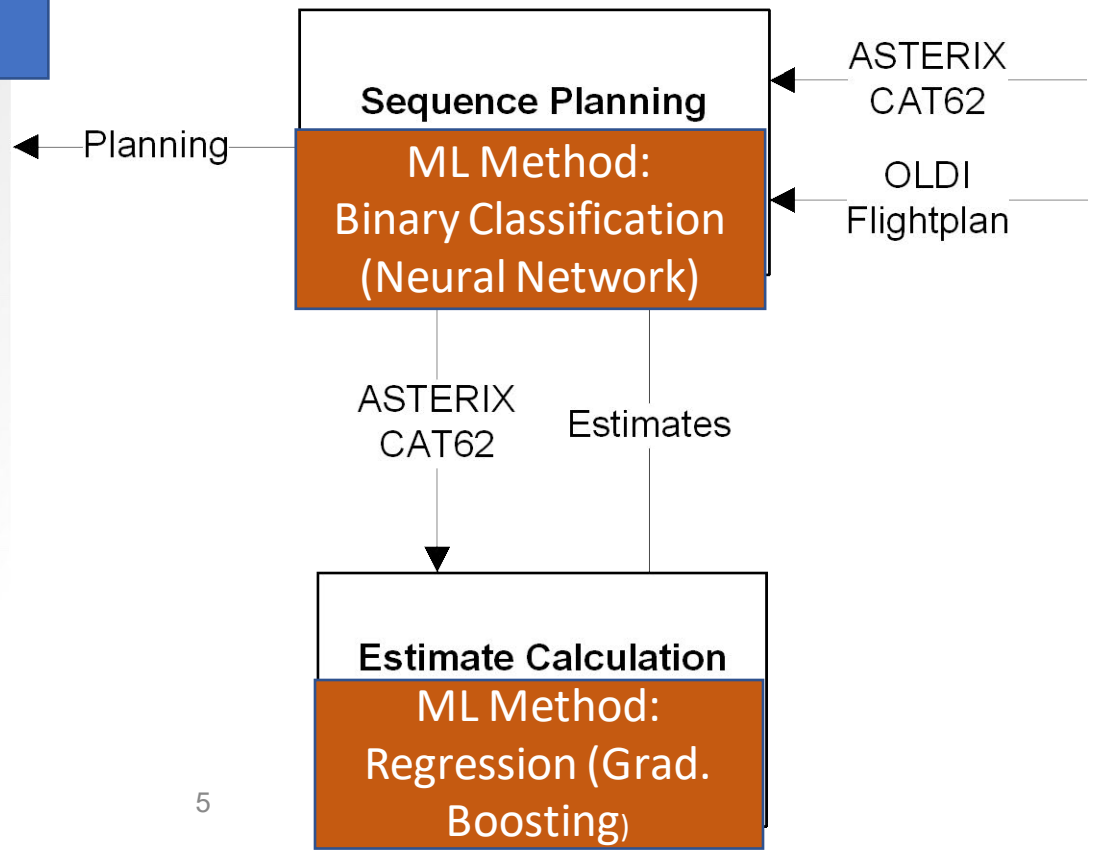
AI Arrival Manager A(I)MAN

The AMAN main functions are realized with machine learning (ML) methods.

- Sequence calculation: Binary classification with a neural network
- Estimate calculation: Regression with a gradient boosting method

Typical Approach Display for 2 Runways





Key Findings for A(I)MAN

Training Data for Duesseldorf Arrivals:

- Data of 1 Month
  - ~ 10k arriving flights
  - ~ 200 Radar updates per flight
  - ~ 30% RWY05 and 70% RWY23
  - ~ 180 NM Planning Horizon

Test Data for Duesseldorf Arrivals:

- Data of 1 (different) Month
  - ~ 10k arriving flights
  - ~ 200 Radar updates per flight
  - ~ 65% RWY05 and 35% RWY23
  - ~ 180 NM Planning Horizon

Binary Classification of Aircraft Pairs (Sequencing)

	Success Rate RWY 05	Success Rate RWY 23
APP < 50 NM	0.97	0.97
ACC < 180 NM	0.91	0.92

Estimate Calculation with various (ML) Methods (RMS Error Landing Time - Average)

	RMS Error RWY 05	RMS Error RWY 23
Conventional estimator	T_{RMS_C} (05)	T_{RMS_C} (23)
Neural Network	- 8%	-13 %
Gradient Boosting	- 24 %	- 24 %

Key Findings for A(I)MAN

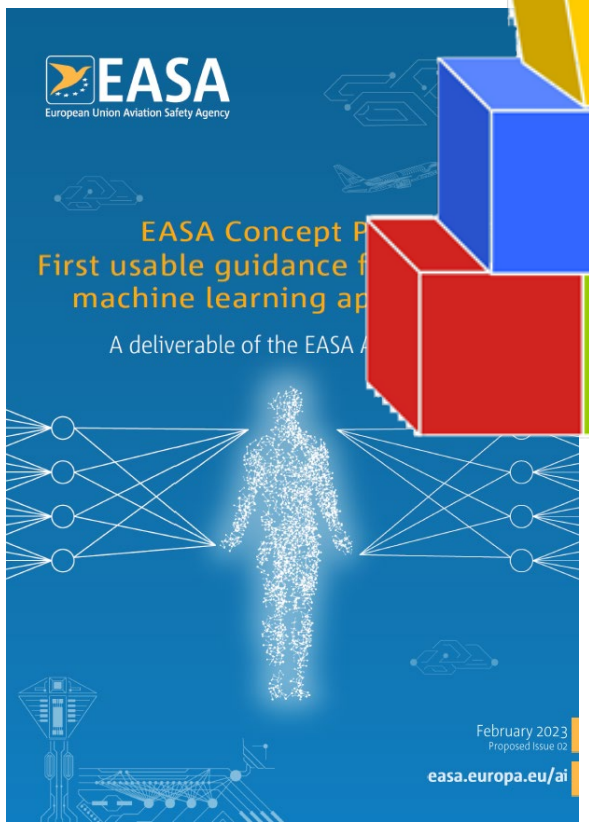
Compared to a conventionally rule-based developed AMAN System, the following benefits can be shown:

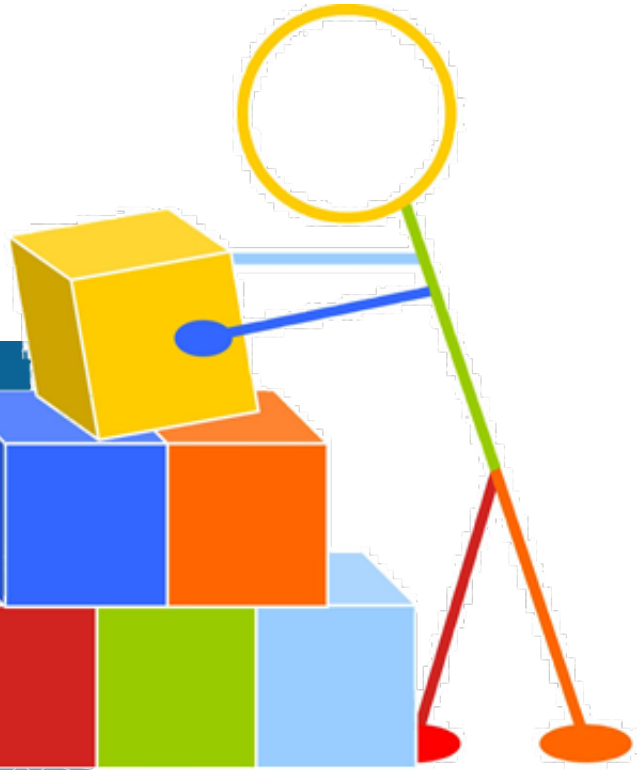
- Arrival planning quality is equivalent or better
- Quality of arrival planning can be assessed with historical data → no or only little real time simulations with air traffic controllers are necessary
- No more ATC knowledge is needed for programming the AMAN → the knowledge is contained in the (training) data itself
- Amount of source code is strongly reduced (less then 10 %)
- Adaptation to another airport is possible within one day only by training new models → about 1 month of training data needed
- Simulation runs with Air Traffic controllers show good acceptance

A(I)MAN in the context of ATM regulations

- A(I)MAN is a controller assistance tool
- A(I)MAN has been tested and verified within a funding project on AI certification (KIEZ with a.o. DLR, EASA)
- In the future particular ATM equipment will be subject to certification by EASA
- Currently we apply the equipment verification and validation procedures, including software assurance, as they are used today,
  - which needs to be extended by the AI relevant additional steps for the management of the data and the learning process including their verification and validation

→ in progress, based on EASA guidelines





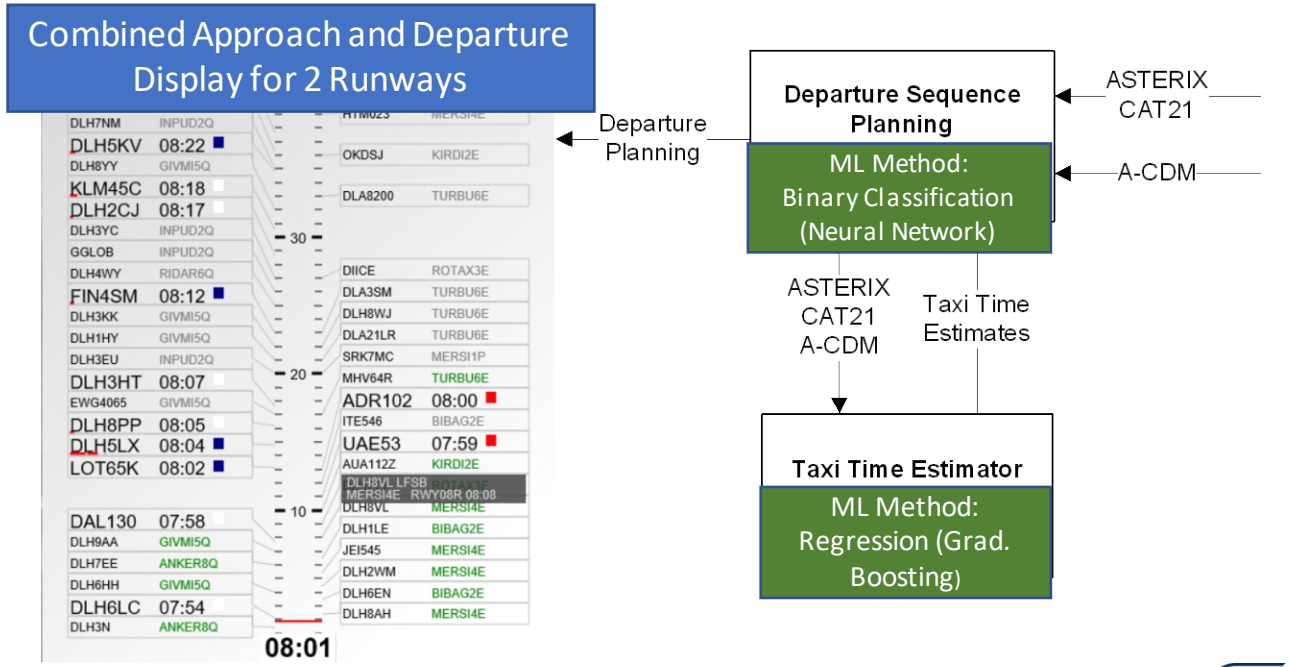
Outlook

The following functions could also be realised for A(I)MAN by ML methods:

- Sequence computation through multinominal classification model
- Separation monitor for pairs of aircraft during turn on final or on final (regression model)
- „Miles to Fly“ computation (regression model)

On the same basis a D(I)MAN could be developed:

- Computation of departure times and departure sequence for traffic on ground with ADS-B data



Benefits and Challenges for AI Applications for ATS

Strategic Fit:

- AI Applications are on the strategic roadmap for many Air Navigation Service Providers

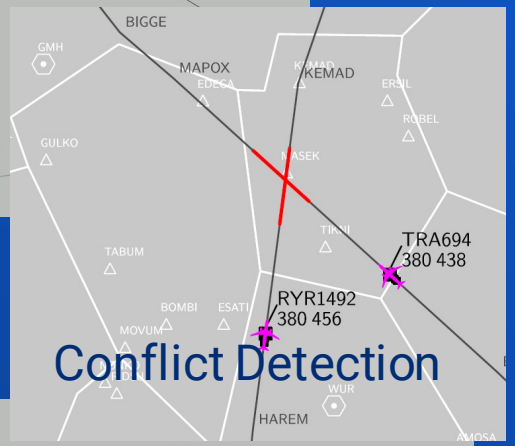
Main Benefits:

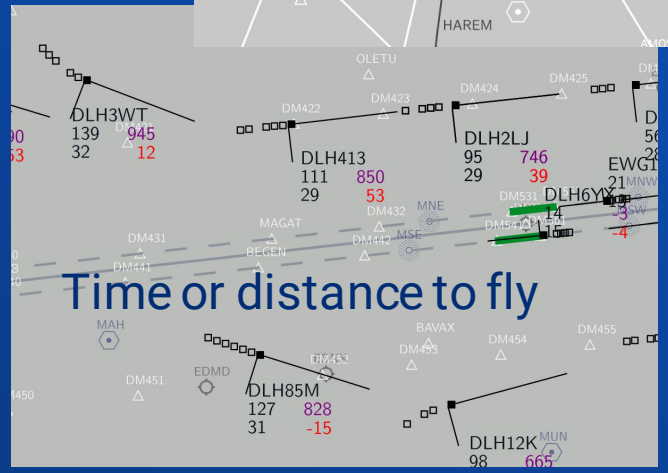
- Developing new ATS applications and unlocking unexplored potentials (new data, e.g. voice)
- Improving existing ATS applications
- Reducing development efforts and costs for ATS applications

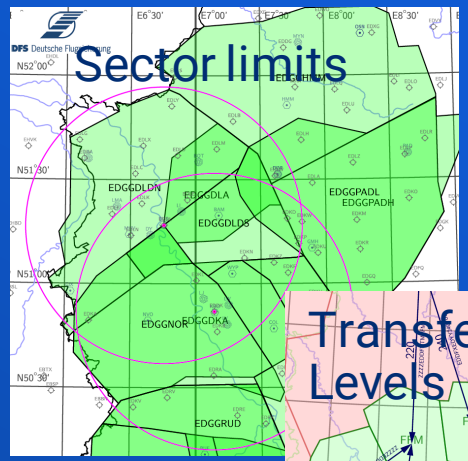
Main Challenges:

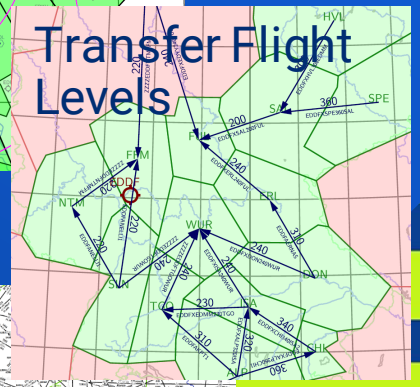
- Data availability / accessibility
- AI/Data factory for continuous development/improvement
- AI acceptance and certification (Use/Role of XAI)
- Integration and deployment in ATS-System (Service-oriented framework)

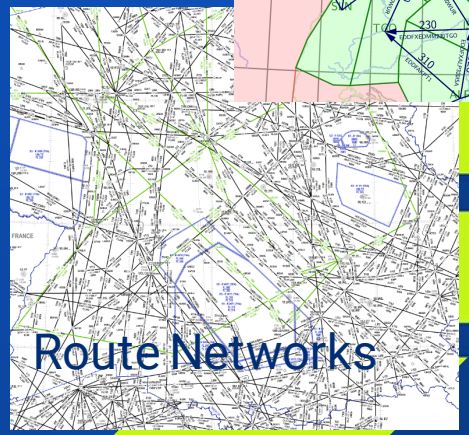
AI@DFS











Thank You!

Contact: frank.zetsche@dfs.de

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