Introduction to Validation and Impact Assessment of TBO

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NLR

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SESAR JOINT UNDERTAKING

Founding Members
EUROPEAN UNION EUROCONTROL

OptiFrame

Workshop

Agenda:

10:00 - 10:15 Registration

10:15 - 10:30 Welcome and introduction of participants

10:30 - 10:55 The OptiFrame project and workshop objectives (ULANC)

10:55 - 11:10 Coffee break

11:10 - 11:20 The COPTRA project (CRIDA)

11:20 - 11:30 The PARTAKE project (UAB)

11:30 - 12:00 Introduction to TBO within OptiFrame scope and items to be discussed (ULANC):

12:00 - 12:30 Discussion Session 1 (ULANC)

12:30 – 13:30 Lunch

13:30 - 14:00 Discussion Session 1 continued (ULANC)

14:00 - 14:25 Introduction to validation and impact assessment of TBO (NLR):

- **TBO and disturbances**
- **Identification of relevant KPAs/KPIs**
- **Proposal for Operational Scenarios**

14:25 - 15:10 Discussion Session 2 (NLR)

15:10 - 15:30 Coffee break

15:30 - 16:00 Conclusions and next steps (ULANC)

Introduction to Validation and Impact Assessment of TBO

Theme of this session:

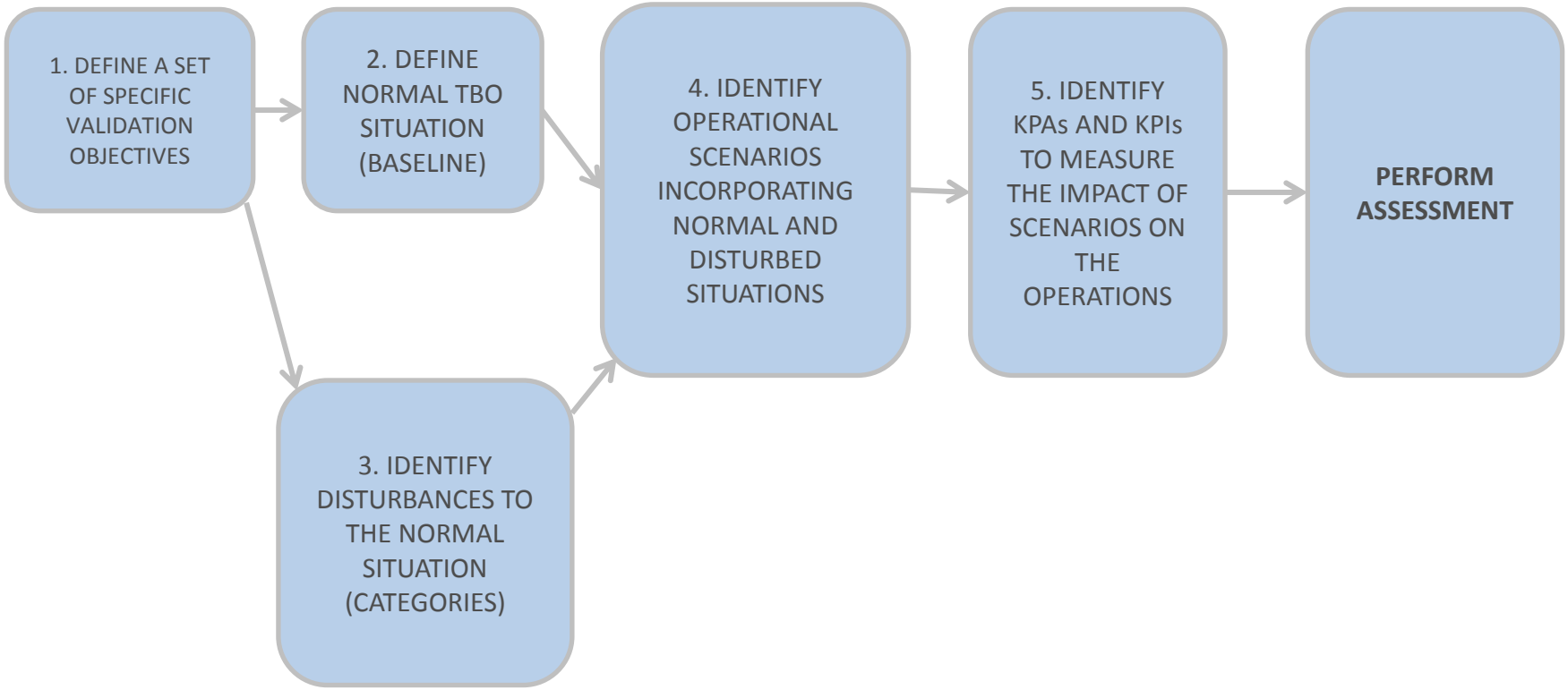
How to assess the impact of the OptiFrame TBO solutions on your operations?

Contents of this session:

1. Validation goal and methodology (NLR)
2. The baseline scenario
3. TBO disturbances
4. Operational scenarios
5. KPAs and KPIs
6. Questions/comments/suggestions

Validation Goal & Methodology

- **Goal: to perform an initial performance assessment of the TBO solutions offered by the OptiFrame optimisation approach**
- **How?**



Questions to be answered

Questions:

1. What is a suitable baseline scenario?
2. Which disturbances to normal operations should we take into account?
3. Which scenarios should we define to incorporate these disturbances?
4. Which would be relevant KPA/KPIs to measure the impact of these scenarios on your operations?

1

What is a suitable baseline scenario?

What is a suitable baseline scenario?

Suitable baseline scenario to assess the OptiFrame TBO models:

- Baseline TBO scenario: reference scenario describing the nominal, non-disrupted TBO case. E.g. set of three ECAC-wide days of traffic:
  - Busy summer day 2016 (current-day traffic)
  - Forecasted busy day in 2022 (+25% traffic compared to 2016)
  - Forecasted busy day in 2050 (+100% traffic?)
- Variations in the nominal scenario:
  - Prioritisation: airspace users will prioritize their flights to make sure flights with the highest business priority are least impacted.
  - Route preferences: airspace users will identify preferred trajectories to make sure that their flights follow the most efficient path.
- Note: In the baseline scenario ‘nothing goes wrong’

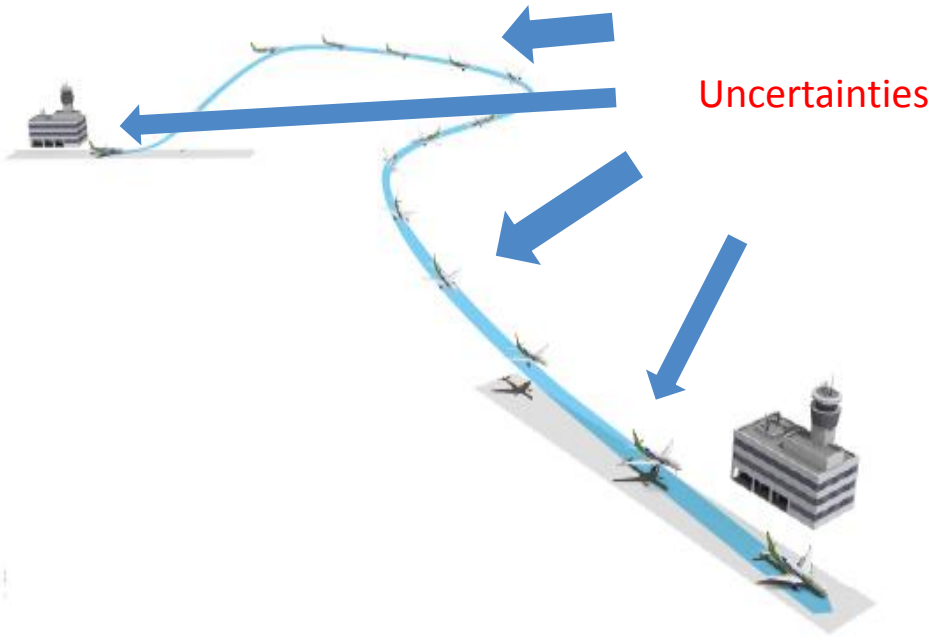
2

What are relevant disturbance categories?

What are relevant disturbance categories?

Background:

- Within the TBO concept aircraft fly their shared and commonly agreed 4D trajectories
- Numerous uncertainties play a role, many disturbances may occur during flight execution....



What are relevant disturbance categories?

Main disturbance categories:

1. Uncertainty in weather data (wind, temperature, weather events) leading to uncertainty in ground and airborne predictions
2. Uncertainty in the turn-around process due to irregularities with security, passengers, fuelling, aircraft maintenance, baggage handling, and others
3. Uncertainty in aircraft performance for ground-based operational actors due to variations in pilots' aircraft handling, airline policies, and unknown aircraft characteristics
4. Uncertainty due to interactions between flights, e.g. their sharing of limited resources like airspace, runways, and ATC capacity
5. Uncertainty due to incomplete synchronisation of information between stakeholders

3

What are relevant operational scenarios?

Scenario 1: unforeseen wind changes

Airborne wind change scenario: unforeseen upper-air wind changes impacting aircraft trajectories.

- E.g. in-bound flights from the U.S. arriving early due to unforeseen jetstream increase.
- E.g.: changes in wind direction and speed in upper-air over Germany impacting all flights passing there in a N->S or S->N direction.
- TBO: adaption of 4D trajectories may be required to allow for a fuel-efficient flight and/or to balance the unforeseen demand with the available arrival capacity at destination airports.

Scenario 2: airspace restriction scenario

Airspace restriction scenario: a scenario involving unforeseen limited airspace capacity impacting a number of flights.

- TBO: e.g. air segment re-routing required.

Scenario 3: airport restriction scenario

Airport capacity restriction scenario: capacity restrictions due to adverse weather conditions (strong crosswinds, limited visibility etc.), leading to a sudden decrease of in-bound and/or outbound capacity.

- TBO: measures required to balance (delay/hold/divert) the arrival demand flow with the decreased arrival capacity of the airport.

Scenario 4: aircraft turnaround delay scenario

Aircraft turnaround delays: scenario in which delays incurred during turnaround affect a number of aircraft (both direct and knock-on effects). E.g. due to security issues, no-show passengers etc.

- TBO: 4D trajectories of departing flights should be updated and the knock-on effects of the current and predicted delays should be taken into account.

Scenario 5: airport closure scenario

Airport closure: a scenario involving sudden closure of one or more airfields due to a security situation, strike, etc.

- TBO: sudden need to adapt 4D trajectories to allow for a diversion to other airports in the vicinity.

Scenario 6: aircraft performance variations scenario

Aircraft performance variations: variations in pilots' aircraft handling, airline policies or unknown aircraft characteristics leading to small but increasing deviations in the 4D trajectories flown.

- TBO:
  - Needs to be robust enough to allow for limited variations
  - Needs to identify these deviations at an early stage in order to minimize overall traffic flow impact.

Scenario 7: insufficient synchronisation scenario

Insufficient synchronization of information between stakeholders: a stakeholder or a group of stakeholders has incomplete, outdated or wrong information regarding particular flights.

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What are relevant KPA/KPIs?

Which are relevant KPA/KPIs?

5 main KPAs in SESAR retrieved from the 11 ICAO KPAs:

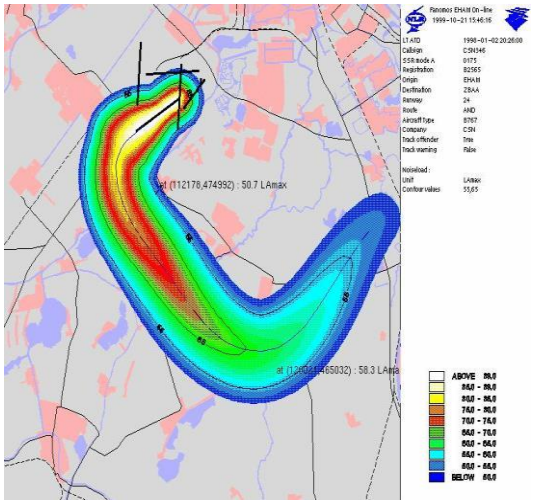
1. Environment
2. Fuel Efficiency
3. Capacity (both airport and airspace)
4. Predictability and punctuality
5. Cost Effectiveness

Other KPAs include: Safety, CBA inputs, Security, Flexibility, Civil-Military Cooperation, Human Performance, and Access and Equity. These are out of scope for OptiFrame.

KPA: Environment

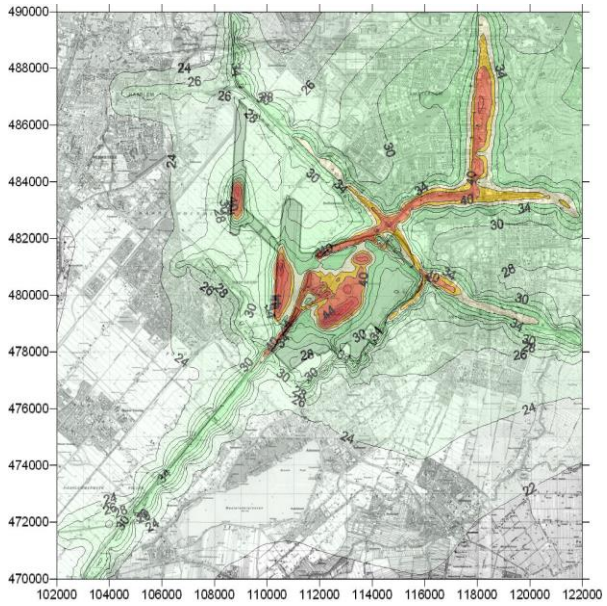
Environment: Noise

- Definition: unwanted sound experienced by people
  - KPIs e.g. :
    - Size and location of noise contours
    - Number of people exposed to noise levels exceeding a given threshold



Environment: LAQ

- Definition: pollutant concentrations in a specific geographical area
  - KPIs e.g. concentration in µg/m^3 for:
    - NOx: Nitrogen oxides
    - SOx: Sulphur oxides.
    - CO/CO2: Carbon monoxide/dioxide
    - PM: Particulate matter



KPA: Fuel Efficiency

Fuel Efficiency:

- Definition: Fuel burn (kg/movement) of the trajectory, or fuel burn deviation from the optimal path (great circle distance)
- Example KPIs:
  - Average Taxi in/out fuel burn per flight
  - Average On stand fuel burn per flight
  - Average TMA arrival/departure fuel burn per flight
  - Average En Route fuel burn per flight

KPA: Capacity

A) Airspace Capacity:

Throughput in number of IFR movements per volume of airspace / time unit

- KPIs:
  - Nr of en-route movements per hour and per airspace sector
  - Nr of TMA movements per hour and per TMA airspace

B) Airport Capacity:

Airport capacity measured in number of departure and arrival flights per hour

- KPIs:
  - RWY throughput per hour (movements/hour)
  - Departure/arrival throughput per hour (departures or arrivals/hour)

KPA: Predictability & Punctuality

Predictability and Punctuality:

- Dependent on: Variability of operations at the airport, in the TMA, and en-route
- KPIs e.g.:
  - Taxi in/out variability (variance of the distribution of actual taxi-in/out duration vs. planned taxi-in/out duration, in minutes).
  - Or alternatively: % departures departing > +/- 3 min from their scheduled departure.
  - TMA arrival/departure variability (minutes)
  - En Route variability (minutes)

KPA: Cost Effectiveness

Cost Effectiveness:

- Definition: Cost Effectiveness measured in terms of controller productivity (for ASPs) or direct/indirect operating costs (for AUs)
- KPIs for ASPs e.g.:
  - Nr of flights handled per ATCO-Hour on duty (Nr of flights)
  - Direct ANS Gate-to-gate cost per flight (EUR)
- KPIs for AUs:
  - Minutes of delay saved (minutes)
  - Direct operating costs (EUR; costs directly related to a specific flight)
  - Indirect operating costs (EUR)

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Questions

Questions/comments/suggestions?

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Thank you very much for your attention!

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