



Dedicated to innovation in aerospace

# R&D solutions for Air Traffic Management



Royal NLR - Netherlands Aerospace Centre



# Welcome to Royal NLR

NLR has been an ambitious, knowledge-based organisation for more than hundred years now, with a deep-seated desire to keep innovating. Our staff search tirelessly for new technology and have the courage to think outside the box, translating trends and developments into actual solutions for the market. Our in-house applied research ensures that NLR stays on top of new developments and innovations. That drive is helping us make the world of transport safer, greener, more efficient and more effective.

It is a challenge to accommodate the growing number of flight movements both in the air and on the ground. The growing demand for capacity at and around airports require innovative solutions. Within the Air Traffic Management domain the possibility for facilitating capacity increase will depend on the quality of planning and automation, and the ability to operate sustainable.

We invite you to discover more about the research and services we develop for ANSPs, government and other clients who are dealing with efficiency, capacity, capability and safety improvements, environmental engagement, human factors and more. Air Traffic Management requires frequent updates and modifications in order to comply with the newest regulations, address efficiency, capacity, sustainability and operational issues or improve the operational performance.

The projects in this brochure showcase our unique approach.

Royal NLR – Netherlands Aerospace Centre

## Capacity & Efficiency



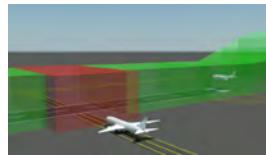
## Flight Operational Support



## Human Performance



## ATM Safety



## Training



## Environment & Community Engagement



# NLR Aerospace Operations Facilities





# NARSIM Tower

## Real-time ATC simulator for training and research into HMI aspects, tools and concepts of tower air traffic controllers

NARSIM Tower can be configured from a single screen setup to a 360 degree tower setup using a projection system. The type and number of working positions is fully flexible and can be reconfigured at any time.

The tower simulator can simulate realistic weather conditions, such as bad visibility, snow and rain and also supports day and night view. Also Electronic Flight Strips are available. NARSIM Tower has a proven track record and has been used as validation platform in European ATM research (SESAR) by research centres and ANSPs. The pseudo pilot positions are uniform for NARSIM Radar and Tower and can be used for both simulators.

### Topics

- Validation of (Advanced) Surface Movement Guidance and Control Systems (A-SMGCS)
- Validation of Human Machine Interfaces for controller working positions
- Studies of airport capacity, safety and efficiency under dense traffic and marginal visibility
- Testing and optimisation of future tower procedures and airport infrastructures, including legislation and safety assessment
- Development and validation of ATM automation tools, including data link applications, by Collaborative Decision Making (CDM) and Gate-to-Gate operations;
- Remote Tower operations, including video surveillance support



# NARSIM Radar

## Real-time ATC simulator for training and research into HMI aspects, tools and concepts of Radar air traffic controllers

NARSIM Radar can be configured to the desired number of working positions. Each working position can act as a tactical, planner or feeder position for either controlling en-route, area or approach (terminal area) traffic.

An integrated radio/telephony systems allows the controller to contact pilots, other controllers or neighbouring sectors or centres. A separate pseudo pilot area allow pseudo pilots to control the aircraft.

### Topics

- Research into Human Machine Interfaces (HMI)
- Air traffic controller assistance tools
- Development, visualisation and validation of ATM concepts and procedures
- Support of qualitative and quantitative safety assessment
- Applications of data link and Air Ground integration in general
- Shadow mode validations in an operational environment
- ATC courses and controller training
- Demonstrations
- Prototyping



# NARSIM Remote Tower

Real-time ATC simulator for training and research into HMI aspects, tools and concepts of tower air traffic controllers

NARSIM Remote Tower can be configured using any desired number of HD or 4K screens or projections system. Multiple Remote Tower is supported and can be configured to be shown vertically or horizontally using a curtain slider. The system includes a Pan Tilt Zoom camera function. This facility can be used both for research as well as for training purposes.

## Topics

- Validation of Multiple Remote Tower concepts
- Prototyping of Remote Tower systems
- Planning tools for Multiple Remote Tower operations

# U-space and UTM-ATM integration

## THE CHALLENGE

Urban Air Mobility (UAM) is the latest mobility revolution, enabling faster, more efficient and sustainable transport solutions throughout urban areas. However, there are a number of challenges to overcome in order for UAM to become a reality: such as the organisation of the lower-level airspace, the scale up of operations in a safe way, integration with ATM, the development of an architecture system and infrastructure that can support operations and public acceptance. Research and innovation into Urban Air Mobility and U-space development will enable the deployment of this new transport mode.

## HOW CAN WE SUPPORT YOU?

NLR has vast experience with U-space and UAM topics, being involved in several national and European projects for the development and implementation of U-space and drone operations. NLR is in contact with governments, industry, research centres and universities, ensuring that knowledge of U-space and UAM is spread throughout the whole value chain. As such, NLR has been a key player in taking the actions to enable drone operations in the Netherlands and is also an advisor for its implementation in other European countries.

We recently developed a research agenda for drones in cooperation with all major Dutch stakeholders that will form a guideline for a national and international strategy for the Dutch government up to 2030. NLR also developed the U-space roadmap for the Dutch government for the rollout of the U-space services between 2021 and 2025. At a European level, we are active in several SESAR projects for the integration of drones in the airspace, the development of the U-space ecosystem, deployment of UAM, and ATM-UTM integration.



## A SELECTION OF OUR CAPABILITIES

- **U-space and UAM ConOps development**  
NLR has vast experience in creating operations concepts for UAM, detailing the procedures, requirements and system configuration for the performance of drone flights.
- **U-space implementation**  
NLR is an active player of the U-space ecosystem, looking into the development of U3 and U4 services and serving as a testing and validation partner for its deployment. We are especially active in separation and conflict management services, looking into Detect and Avoid systems and procedures to improve the safety of operations.
- **ATM-UTM integration**  
The work performed in U-space implementation has to be coordinated and integrated with regular ATM procedures. NLR is involved in the development and validation of procedural and collaborative interface U-space services to facilitate ATM-UTM integration.
- **UAM vertiports development**  
The conceptualisation of vertiport operations as well as the definition of infrastructure requirements and processes to support drone operations. NLR has the ambition to develop a vertiport at the Amsterdam office, besides the current NLR drone test facility in Marknesse.

# FlightCatcher

## Providing insight on flight track data for the public

### THE CHALLENGE

Transparent communication is essential for airports, airlines and ANSPs to build a good relationship with the people who live near the airport. Providing information and explaining where airplanes fly and why they deviate from a normal situation is one of the most challenging tasks in communicating with your community.

### Goals

- Provide insight on flight operations
- Improve relationship with local communities
- Reduce costs for complaint analysis

### HOW FLIGHTCATCHER CAN SUPPORT YOU

In close cooperation with the German ANSP Deutsche Flugsicherung DFS, Royal NLR developed the web-based flight tracking service FlightCatcher. This service is based on NLR's long-term experience in radar data processing, flight track monitoring and environmental impact calculations. As part of the airport's community engagement strategy FlightCatcher offers the general public insight into air traffic with maximum transparency.

### FlightCatcher:

- an online communication tool for displaying aircraft operations and environmental impact (noise) in an understandable manner via the Internet See DFS STANLY\_Track as a solution for communication about German air traffic ([click here to visit the DFS application](#)) visualisation and analysis of real-time flight movements and historical flight tracks
- accurate replay of flights for analysis of historical flight data
- functionality showing nationwide detailed flight information
- Building of public understanding of complex airspace around an airport
- Creation of dedicated systems for those customers looking for a tailor-made product that is adaptable to other modules such as environmental impact (noise)



### **Our fatigue assessment services comprise:**

- Performing work schedule evaluations for fatigue avoidance, for instance based on mathematical models
- Benchmarking on work limits and minimum rest regulations.
- Fatigue, sleep and alertness measurements on ATCOs in a non-intrusive manner (e.g. using logbooks, mobile app, eye tracking or actigraphy).
- Tailored fatigue mitigation interventions including briefings, surveys, interviews and / or workshops.



# Fatigue Risk Management for Air Traffic Service Providers

## THE CHALLENGE

Fatigue is a well-recognised human factor that leads to reduced alertness and subsequent safety issues, and needs to be adequately managed. Since fatigue can be caused by a wide variety of factors such as workload, night shifts, sleep debt or circadian disruption, fatigue risk management and mitigation is not an obvious and straightforward task.

Since 2020, the International Civil Aviation Organization (ICAO) amendments to Annex 11 require that ICAO States establish duty limits and specify certain scheduling practices for air traffic controllers. Hence, ANSPs have to implement their fatigue management processes and procedures in accordance with ICAO guidance and States regulations.

Assessing the contributing factors in your organisation is essential in order to implement tailored and effective fatigue risk management strategies.

## HOW WE CAN SUPPORT YOU

The way in which a fatigue risk management system (FRMS) is implemented very much depends on the ANSP. First we need to identify the current situation of the ANSP, so as to establish what the ANSP aims to accomplish and how the ANSP can be supported. For example, if an ANSP intends to optimise its fatigue level status, it requires a different approach from a benchmark against other organisations, ensuring that all regulations are implemented correctly. NLR can support ANSPs in focusing on what is important for its specific situation.

NLR can bring together workplace, organisational, regulatory and scientific expertise through an inspiring team of human factors, training and safety experts. We provide assistance in developing and implementing optimal work schedules, the identification of fatigue causes and hazards in your organisation, or FRMS optimisation. Our support is modular and can be tailored to specific ANSP needs and preferences.



**We support ATCO training organisations with specific, client-tailored modules including:**

- EBT program implementation (gap-analysis)
- evolution workshops to support the transition to EBT
- instructor EBT courses
- data-analytics-as-a-service to identify specific, and even individual, training needs
- measurement of program training effectiveness and
- measurement of instructor concordance.

# EBT Evidence Based Training

## Implementation and Performance Support

### THE CHALLENGE

How can you make training as efficient as possible, in terms of time and budget? We believe that high-quality EBT is ideal for both the ANSP and the ATCO alike. EBT was developed over the last ten years, combining evidence (data) driven training with competency based training. EBT generates competency data and uses this data to adapt the ATCO's recurrent training to focus on actual competency training needs. In this way, EBT provides an elegant framework to continuously improve ATCO core competencies.

EBT aims to develop ATCOs in several core competencies, instead of providing training in a narrow, familiar and repetitive set of tasks. By developing competencies, an ATCO is effectively prepared to manage safety and performance in many different situations, not only those explicitly trained for.

Evidence Based Training offers that additional efficiency because it:

- Automatically adapts the training to the needs of each individual ATCO. No time is wasted on competencies which are already mastered by this ATCO.
- Provides training in several core competencies which allow ATCOs to act efficiently in an array of situations, without the need to train each individual special situation separately.

### HOW WE CAN SUPPORT YOU

NLR assists operators in achieving reliable ATCO development programmes. Our support modules are highly engaging, interactive and specifically designed to empower training managers, instructors and National Aviation Authorities (NAAs) to deliver and oversee effective competency-based training and assessment (CBTA) in the form of EBT.



# Airspace and flight procedure design

## THE CHALLENGE

All over the world airspace is experiencing the emergence of new civil and military users, both manned and unmanned. However, airspace volume is physically limited, the aviation industry needs to reduce its global environmental impact but capacity growth is expected to grow again to pre-corona times. With these constraints, there is a need for an efficient and well organised airspace.

Existing airspace and flight procedures therefore need to be optimised in order to comply with these efficiency, capacity and environmental constraints. Performance based navigation (PBN) flight procedures are a crucial aspect in this process concerning the modernisation of airspace and flight procedures.

## HOW WE CAN SUPPORT YOU

NLR has the required expertise and internationally recognised software tools to assist ANSPs, airports and governments with their airspace and flight procedure design needs. We are able to perform complete designs from scratch (for example for new airport development) and design modifications to existing airspace or flight procedures.

In short, NLR we can offer you a unique 'one-stop shop' from design to fast time and real time validation, to charting and support to AIP publication. This also includes an in-house flight validation and calibration aircraft to cater for airspace and flight procedure design projects.

In doing so, NLR strictly follows the guidelines and standards as defined by ICAO (e.g. flight procedures design projects ICAO doc 9906), and other international organisations such as Eurocontrol and EASA.

## Airspace and Instrument (or visual) flight procedure design with a focus on PBN procedures

Both standard straight RNP approach procedures and more advanced procedures, such as procedures with the inclusion of Radius to Fix or RNP AR procedures, or even STARS with inbuilt merging and sequencing mechanism.

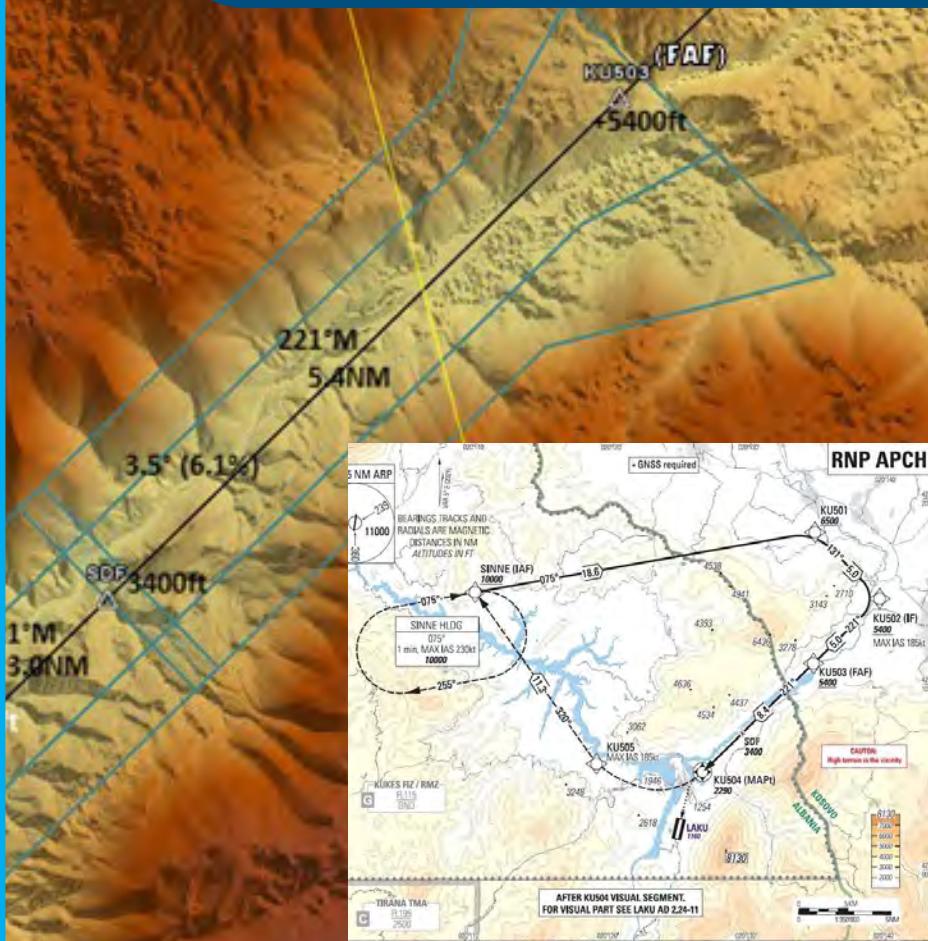
Specific procedures for rotorcraft such as point in space or low level RNP networks are within the capabilities of NLR. Airspace design is feasible for all types of airspace, such as TMA, CTR and ACC.

## Aeronautical studies

These are sometimes needed as part of the flight procedure design process, or for example when new obstacles (e.g. windmills, tower flats, and so on) are planned in close proximity to an airport. These studies are aimed at evaluating the impact of those obstacles on new or existing flight procedures.

## Unmanned aircraft

NLR offers research capabilities for the integration of unmanned aircraft into airspace, developing drone-specific procedures even if no internationally recognised standards exist to date.



# Data science for safety management

## Providing actionable insights from data across a range of application domains

### THE CHALLENGE

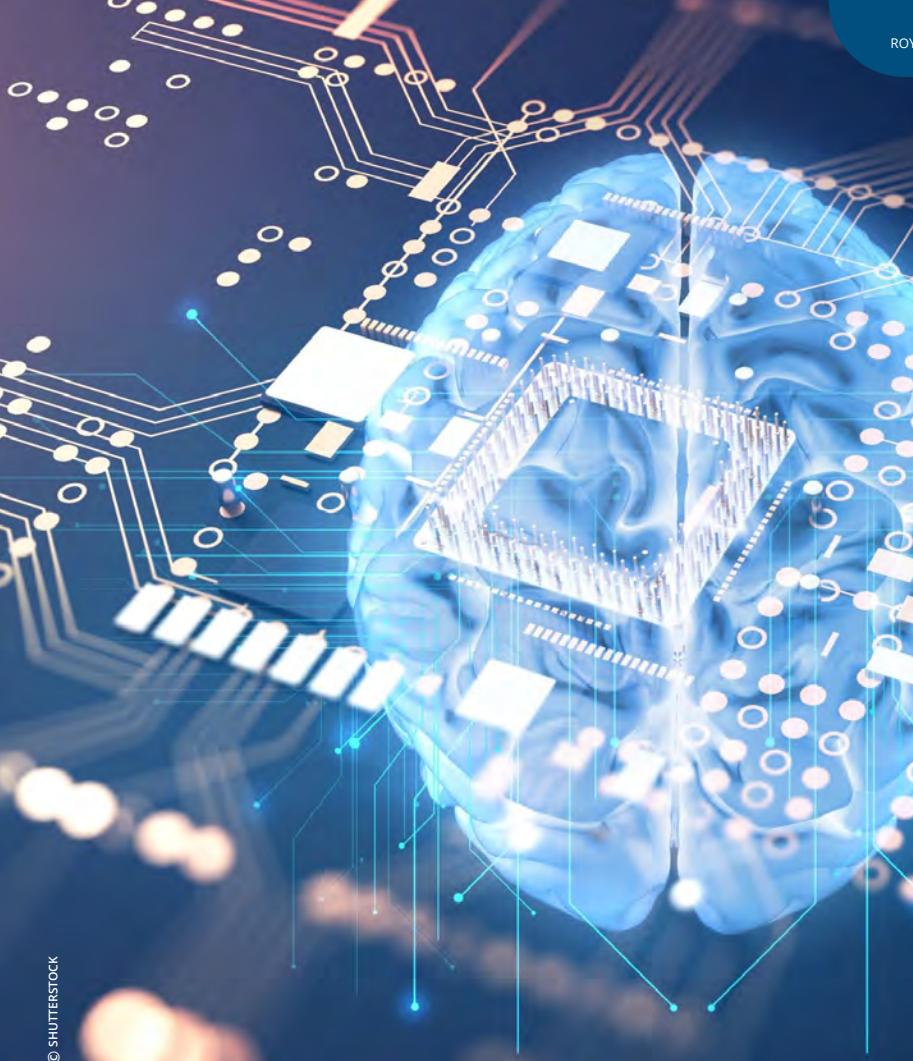
How can you give value and meaning to the abundance of data within your organisation? The application of data-science has the potential to increase the quality of (risk) assessments, better understanding of the effectiveness of control measures, as well as better data-driven decision making. By applying data science techniques, ANSPs may optimise ATM-operation in relation to operational needs. However, many organisations struggle to use the abundance of data to its highest potential, or lack efficiency in data-mining and data-integration.

Data science techniques combine operational expertise, programming skills, mathematics and statistics to extract knowledge, actionable information and insights on safety and operational performance from (operational) data. Data science practitioners apply those techniques to predefined datasets, like radar tracks (Such as NLR's FANOMOS), meteo data, occurrence reports, fleet data etc. Data visualisation is another important aspect of data science.

It provides visual context through maps, graphs and interactive dashboards. This makes the data more natural for the human mind to grasp and makes it easier to identify trends, patterns, and outliers within large data sets.

### HOW WE CAN SUPPORT YOU

NLR has a solid knowledge base and experience and expertise in the application of data science and machine learning in the domain of safety management. Data has the potential to show the effects of changes, such as the introduction of new technologies or procedural changes, in the ATM system on safety, efficiency, human performance and other fields of interest. NLR can identify the best application of data science within ANSPs and translate the operational data of any organisation into actionable insights.



**A selection of our capabilities and services based on data science applications:**

- Automatic classification of safety occurrence reports;
- Automatic detection of 'outlier' flights in flight data or radar data;
- Monitoring of ground radar data for safety (precursor) events and trend analysis, e.g. detection of deviations from standard procedures;
- Data collection and integration of (worldwide) safety and operational data (FLORIS data warehouse, FANOMOS);
- Machine Learning application to analyse causal factors and relations between causal factors in a large repository of accident / incident reports.
- AROT (Actual Runway Occupancy Time) and CTL (Clearance To Land) margin data analysis for implementation of RECAT-TBS.
- Data analysis of radar tracks for ILS Localiser and Glidepath deviations.



# ReFI

## Reduced Flight Inspection

### THE CHALLENGE

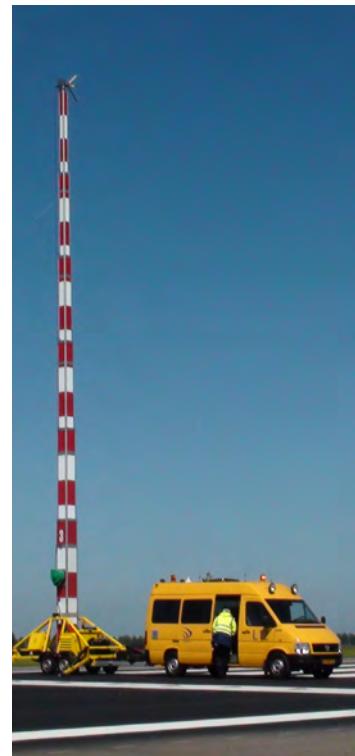
Even though Performance Based Navigation (PBN) instrument flight procedures are becoming more and more common practice for final approach (RNP approaches), many international airports still maintain and operate the conventional Instrument Landing Systems (ILS). NAVAID ILSs require regular maintenance, calibration and inspection. Measurements for ILS calibration are usually carried out by flight tests, ground tests on or near the runway and equipment tests. The calibration part is usually performed by using a flight validation and inspection aircraft. The exercise with a calibration aircraft is expensive in terms of cost per flight hour as well as non-availability time of the runway for commercial traffic. Moreover calibration flights can cause a lot of nuisance for inhabitants due to low altitude flights.

NLR has performed extensive research on the possibilities of inspecting a NAVAID ILS other than by relying on standard calibration and inspection flights. The results of this research have resulted in the more extensive usage of ground-based measurements and usage of data of regular air traffic via the ILS. By using more ground-based and commercial flight data it becomes possible to significantly reduce the number of flights with the regular calibration aircraft. At Amsterdam Airport Schiphol, it has been possible to reduce the number of calibration flights by 50% thanks to this technique!

### HOW WE CAN SUPPORT YOU

NLR can support you with the NLR Reduced Flight Inspection system (ReFI) that will help reduce the number of flights needed for regular ILS calibration and inspection flights, thus reducing the cost for the owner and operator of the ILS, whilst also reducing the nuisance involved for inhabitants living near the airport.

NLR can provide the feasibility assessment as well as the actual implementation roadmap for reduced flight inspection at your airport. The first step usually includes data collection, namely the collection of ILS parameters (such as ground conductivity, antenna heights, terrain curvature). Next steps include simulations, including signal in space validation, followed by NLR's support to actual validation measurements and validation execution.



# Safety case and risk assessment

## Support in dealing with complex safety challenges in ATM

### THE CHALLENGE

It may be necessary to develop or modify air traffic management (ATM) operations and procedures, for example to optimise capacity, efficiency or environmental impact. These new modifications can only be introduced after the safety of the changes has been assessed and deemed to be compliant with appropriate safety criteria. It is very challenging to complete the safety case due to the complexity of safety risks in ATM and because of insufficient insight into the interdependencies across capacity, efficiency and safety. This could lead to poor decision-making and suboptimal ATM performance.

A professional and high quality safety case and underlying (safety) assessment is a precondition for the safe, efficient, environmental friendly and high capacity ATM operation. It requires a thorough understanding of the complexity of ATM operations, technology and procedures, solid methods for safety modelling and risk assessments, and sufficient data to support analysis.

In addition, the presentation of the safety case has to be such that accountable managers and other decision makers are able to act upon it. NLR has a solid track record of delivering those needs for ANSPs.

### HOW WE CAN SUPPORT YOU

NLR's Safety Institute provides support in the development of safety cases, by supplying underlying safety data, expert judgment or process organisation advice. Furthermore, we are able to take responsibility for developing a complete safety case for you. Therefore we use state-of-the-art insights, models and techniques (e.g. data science) to support the development of the safety case. Our key strength is the ability to combine the pure operational and local perspective with the expertise of safety methods, processes and regulations. Our safety assessments methods and models can be applied to various types of air transport safety studies, for instance parallel approaches, operation in limited visibility, taxiway take-off, ground collision, etc.

**A selection of our safety related services comprises:**

- Solutions for increased runway throughput
- Advice on improving your Safety Management System
- Advice on improving your safety culture
- Safety and risk Assessments
- Obstacle Assessments / Aeronautical Studies
- Identification and monitoring of risks
- Support in how to mitigate safety risks



# FANOMOS

## Providing flight data & track information and in-depth analyses

### THE CHALLENGE

There is a continuous need for improved flight efficiency and reduced environmental impact of flight operations. To support this, a trusted basis for flight data is required for the purposes of conducting accurate and detailed analyses. The best approach for a wide range of stakeholders e.g. ANSPs, airports, airlines, community and governments, is to monitor these flight data accurately in real-life.

Benefits:

- Shared flight data for different studies, e.g. environmental impact studies
- Real-life flight data serve as a trusted knowledge base
- Enabler for long-term trend analysis

### HOW WE CAN SUPPORT YOU

NLR has long standing experience in radar data processing, flight track monitoring and environmental impact studies. In FANOMOS (waarstaatditvoor?), data collected from flight data monitoring serve as a solid basis to analyse the impact of flight operations in environmental impact studies, for instance. These studies can be conducted for real-time as well as for historic data. For future scenarios, for which monitored data are not

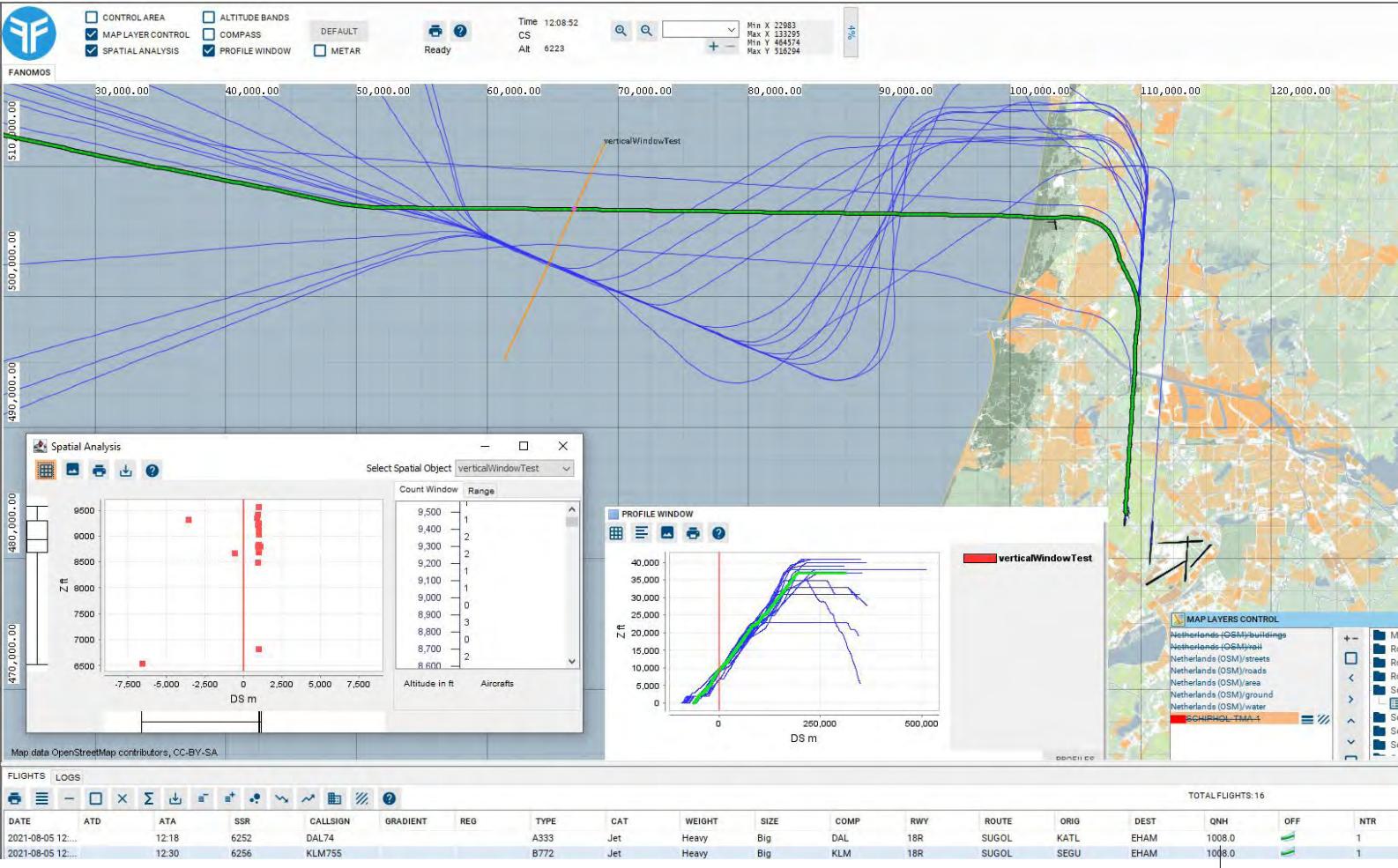
available, simulated flight data can be fed into the monitoring system to compare historic and future situations.

FANOMOS can be offered in different ways:

- FANOMOS software product to be embedded in your own ICT infrastructure
- Access to NLR's FANOMOS server to facilitate your own analyses
- A web service access (REST API) for coupling flight data with your own information systems
- Consultancy services whereby NLR conducts analyses and studies for you

Based on the collected flight data the impact of aircraft operations is analysed and presented. This provides more in-depth insight. Monitoring data facilitate several goals:

- Impact studies such as environmental metrics
- Safety studies
- Flight performance studies and trend analysis
- Facilitate information sharing
- Improvement of model input data



# NLR in brief



One-stop-shop



Global player with  
Dutch roots

100+

Since 1919



Amsterdam, Noordwijk  
Marknesse, Rotterdam



Innovative, engaged  
and practical



For industry and  
government



For fixed and  
rotary wing



650 employees



€ 92 M turnover



72% Dutch, 22% EU  
and 6% international



Active in 30 countries



Extremely high  
client satisfaction

# About NLR

## Royal Netherlands Aerospace Centre

NLR is a leading international research centre for aerospace. Its mission is to make air transport safer, more efficient, more effective and more sustainable. Bolstered by its multidisciplinary expertise and unrivalled research facilities, NLR provides innovative and comprehensive solutions to the complex challenges of the aerospace sector.

NLR's activities span the full spectrum of Research, Development, Testing & Evaluation (RDT & E). Given NLR's specialist knowledge and state-of-the-art facilities, companies turn to NLR for validation, verification, qualification, simulation and evaluation. They also turn to NLR because of its deep engagement with the challenges facing our clients. In this way, NLR bridges the gap between research and practical applications, while working for both government and industry at home and abroad.

NLR stands for practical and innovative solutions, technical expertise and a long-term design vision, regarding their fixed wing aircraft, helicopter, drones and space exploration projects. This allows NLR's cutting-edge technology to find its way also into successful aerospace programmes of OEMs like Airbus, Boeing and Embraer.

NLR supports ANSPs in solving challenges in ATM, helping to ensure effective, safe and sustainable operations.

**Royal NLR is ready to assist in:**

- Real Time ATC simulation
- Developing, prototyping and validating new ATC concepts and tools
- Safety Case and Risk Assessments
- Data Science for Safety Management
- U-space and UTM-ATM integration
- Fatigue Risk Management
- Airspace and Flight Procedure Design
- Flight data & track analysis

**For more information:**

Roland Vercammen

Business Manager Aerospace Operations

**p** ) +31 88 511 31 08 / +31 623 34 77 60

**e** ) [roland.vercammen@nlr.nl](mailto:roland.vercammen@nlr.nl)

**NLR Amsterdam**

Anthony Fokkerweg 2

1059 CM Amsterdam

**p** ) +31 88 511 3113

**e** ) [info@nlr.nl](mailto:info@nlr.nl) **i** ) [www.nlr.org](http://www.nlr.org)

**NLR Marknesse**

Voorsterweg 31

8316 PR Marknesse

**p** ) +31 88 511 4444

**e** ) [info@nlr.nl](mailto:info@nlr.nl) **i** ) [www.nlr.org](http://www.nlr.org)