



Dedicated to innovation in aerospace



# NARSIM

one simulator for ATC Radar and Tower simulations



Netherlands Aerospace Centre



# Intro

The air traffic control environment requires frequent updates and modifications in order to comply with the newest regulations, address capacity and operational issues or improve the operational performance. Requirements for the new or modified procedures and systems can be tested and validated with a real time ATC simulator. This minimizes the risk during the implementation and increases the predictability of the actual operational performance.







# NARSIM

## Research, training, concept validation

NARSIM is NLR's Air Traffic Management Real-time Simulator. It is a high fidelity human-in-the-loop simulator that is used by research centres, ANSPs and universities. The NARSIM software can be used in both Radar, Tower and Remote Tower simulators. The main application areas of NARSIM comprise:

- Concept development and validation
- Prototyping of new ATC systems
- Training

The in-house developed NARSIM simulator makes use of highly realistic aircraft performance models, validated by numerous ANSPs. NARSIM Tower, Radar and Remote Tower have a proven track record and have been used as validation platform in European ATM research (SESAR).



# 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







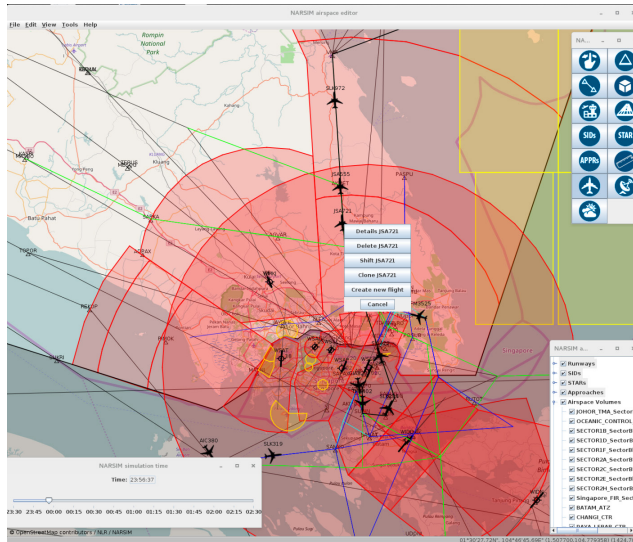
# NARSIM Remote Tower

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



## SOFTWARE

NARSIM is a software product that based on commercial off the shelf hardware consumer hardware. The NARSIM software is scalable and will run in a network with many desktop computers for large scale simulations but will also run on a laptop for demonstration purposes. It interfaces with most simulator and industrial systems allowing the coupling of third party systems like operational ATC systems, other simulators, CNS components and even live-aircraft.

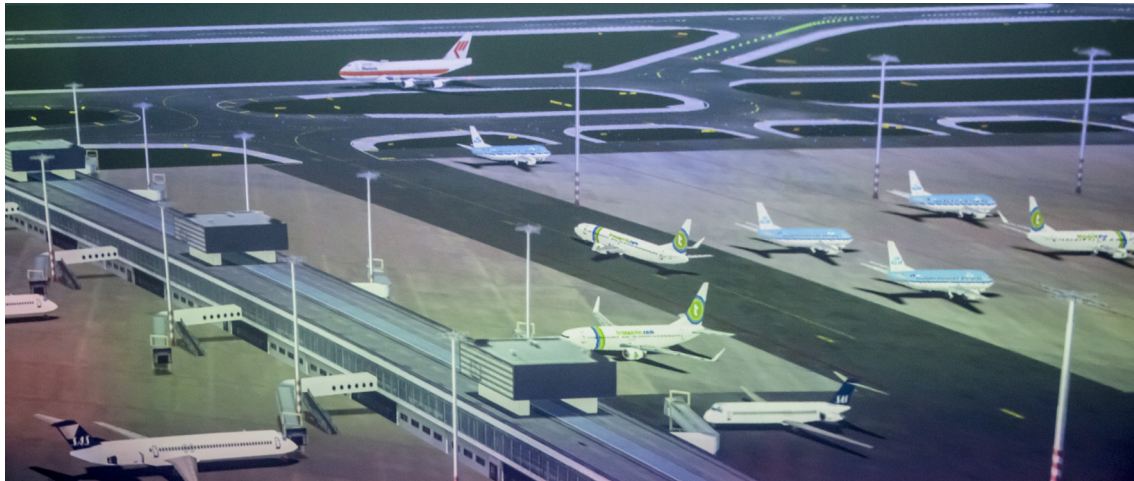


## CONCEPT DEVELOPMENT AND VALIDATION

NARSIM enables visualisation of new conceptual ideas at a very early stage. Ideas can be quickly evaluated towards operational feasibility and they can be communicated to users and stakeholders in a clear and unambiguous way. Early involvement of the user is generally accepted as the single most important factor for a successful introduction of new or changed ATC system or concept.

## TRAINING

NARSIM simulates a realistic environment for the Controller and is used in the development of training as well as in providing of training itself. Training in NARSIM has been provided ranging from recurrency training of an operational Electronic Flight Strip System to large scale (50+ actors involved) collaborative decision making training for winter operations. Record and play-back is just one of the training features of NARSIM.



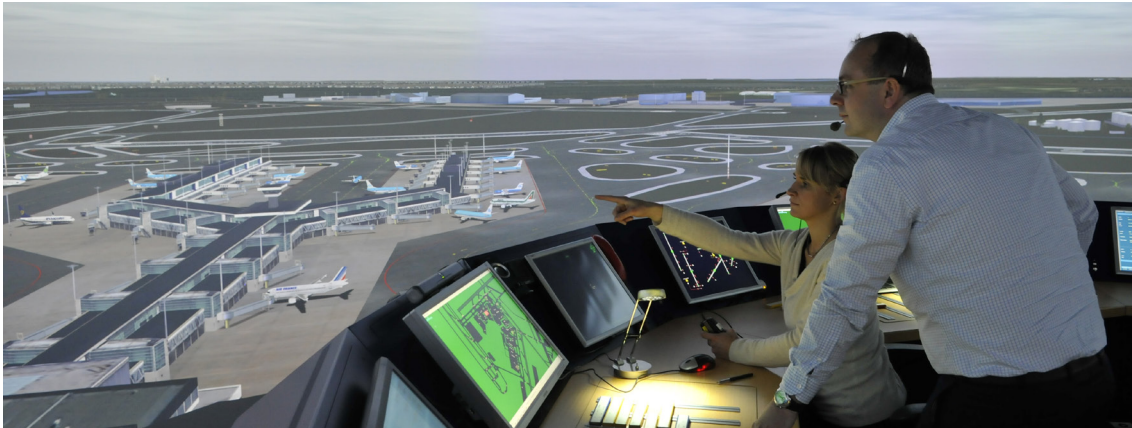
## **PROTOTYPING**

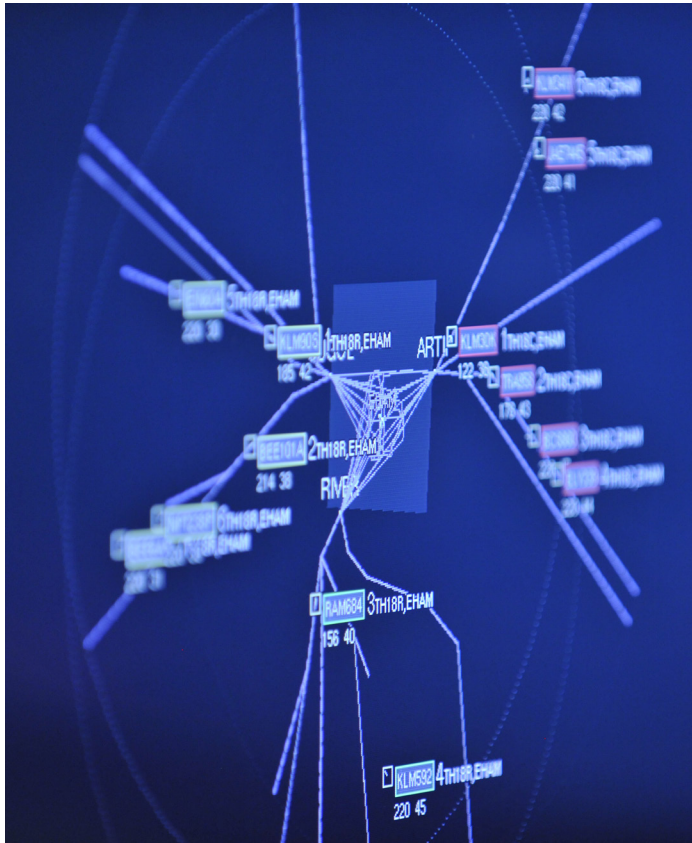
NARSIM is highly configurable and well suited for applications where the human aspect plays an essential role, such as development of the Human Machine Interface (HMI).

Rapid prototyping allows for fast experimental or pre-operational evaluation of new HMI specifications.

## **VISUAL SYSTEM – NARSIM Tower**

The visual system of the NARSIM Tower facility consists of a 360° projection screen with a diameter of 11 meters and a height of 4.5m. The projection system has a high resolution, luminance and contrast ratio. A variety of meteorological phenomena such as rain, snow, fog and clouds can be simulated in different seasons and under daylight and night-time conditions. Detailed databases of many European airports are available and can be imported or even created in-house.





### SOFTWARE - NARSIM RADAR

Radar software is designed around advanced object-based client/server architecture and is inherently scalable. Its modular design allows running the entire simulation distributed among several independent platforms on a local network or internet in fast-time or real-time. It supports logging and playback on several levels (network messaging, operational parameters, events, audio and video). Multiple instances of the same module can be easily monitored, started, restarted, or relocated whilst running the simulation.







## HUMAN FACTORS

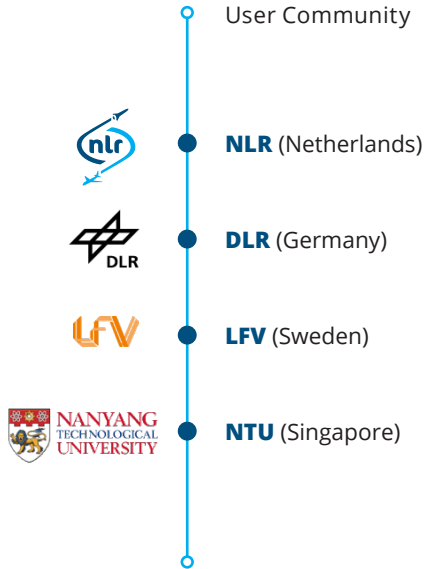
Human Factors assessment for Air Traffic Control is important when new concepts, systems, devices and technologies are introduced.

Introduction of significant operational changes, such as remote tower operations, requires ATCos to be able to handle these changes. In order to ensure that ATCos will indeed be able to operate efficiently, in a safe manner and in a comfortable way many questions need to be answered.

Human Factors research can contribute to answering such questions. To name a few:

- Do ATCos have the same situational awareness as in the conventional tower?
- Do ATCos have an accurate out-of-the-window view in the remote tower?
- Do ATCos become confused by the “artificial” way of offering information?
- Does the new operational environment lead to more fatigue?
- Do ATCos experience more workload?
- Will the likelihood that ATCos make a human error change?

## DEVELOPERS



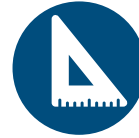
## USERS



# NARSIM user community

The NARSIM User Community is a cooperation between users of NARSIM to enhance capabilities and increase efficiency of using and developing Real-Time Air Traffic Control simulations by sharing NARSIM amongst partners.

- Sharing knowledge and expertise on real-time ATC simulations.
- Sharing development of new ATC tools.
- Increased interoperability for partners.
- Faster set-up and possible re-use of simulations.
- Lower total cost of ownership.



# NARSIM features

## HIGH RELIABILITY

- NARSIM has over 30 years of experience
- High fidelity
- Based on COTS hardware

## HIGHLY REALISTIC

- Used for training of operational Air Traffic Controllers
- Highly realistic BADA based aircraft performance model

## INTEROPERABILITY

- Ability to integrate third party systems whilst maintaining scalability and performance
- Ability to integrate Radar simulator with Tower simulator
- Adherence to industrial interoperability standards

## FLEXIBILITY & MODULARITY

- Short lead-times for changes/modifications
- Fully customisable displays
- Ability to simulate future

- airport operations and controller working positions
- Everything is customisable; from the controller HMI to the arrival management concept
- Developed fully in-house with a focus on modularity and configuration
- Flexibility and modularity due to its open architecture;

## SCALABILITY

- From large scale validation trials to mobile small scale (even laptop based) prototyping and visualisation

## BUILT FOR THE FUTURE

- AR/VR implementations
- Head and eye tracking

## SCENARIO PREPARATION TOOL

- Set-up your airport, airspace and traffic scenario within an hour
- Stand-alone tool, works on any laptop or computer

- Automatic AIP read-in for defining waypoints and sectors
- Easy to use HMI
- Increase/decrease traffic density
- Preview of sector loads and runway loads presented in clear graphs

## DATA POST-PROCESSING

- Generate Google Earth images including indication of instructions
- Determine taxi-times
- Analyse R/T load and sector load
- Analyse number of aircraft in area
- Analyse controller workload using standard questionnaires

## PREPAIR

- PREParation tool for AIRspace and Traffic (PREPAIR)
- Set-up your airport, airspace and traffic scenario within an hour
- Etc.







# NARSIM Product Licenses Available for Radar and Tower

## NARSIM PROFESSIONAL

The NARSIM Professional license type includes binaries with the possibility to configure/adapt to different ATM concepts and environments. The configuration or adaptation may include:

- Scenario adaptation (configuration changes in traffic samples, flight-plans, weather, non-nominal events)
- Configuration of simulation layout and/or size (e.g. number of working positions and allocation of pseudo-pilots, R/T, recording and logging, etc.)
- Configuration or adaptation of airspace structure
- Configuration of traffic autonomous flight behaviour through scripting
- Customised Controller Working Position HMI will be delivered by NLR

The NARSIM PREPAIR tool is included in this license.

This license will provide access to the NARSIM User Community.

## NARSIM DEVELOPER

The NARSIM Developer license type includes everything from the type Professional license, but includes a Software Development Kit (SDK) with which the client is able to adapt parts of existing components or develop its own components that run natively in NARSIM. For these specific components, scripts will be provided enabling software development by the client itself. Available SDKs include:

- NARSIM Server SDK
- Controller Working Position HMI SDK

Specific for TOWER:

- NARSIM A-SMGCS SDK
- NARSIM EFS SDK

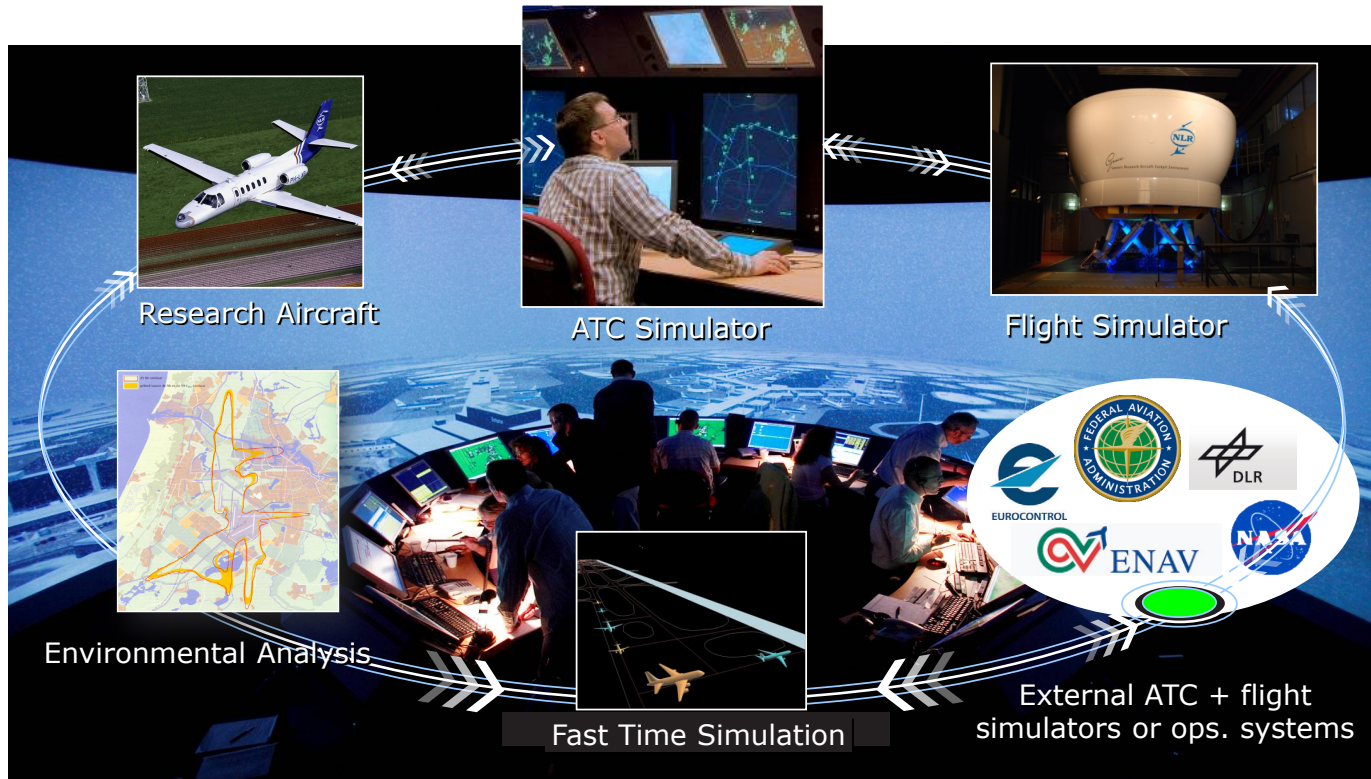
Other SDKs could be developed in consultation.

## NARSIM DEMONSTRATOR

The NARSIM Demonstrator license type is a license which is used primarily by clients for whom NLR has researched an ATM concept using NARSIM at NLR's premises. The end result of such research projects are often the reporting of results and recommendations, but may also include a NARSIM demonstrator platform. This demonstrator platform is for the client to use in demonstrations of the researched ATM concept to its stakeholders on the clients premises. It is fixed in setup and scenarios.



# NLR Aerospace Operations Facilities





# Showcases





# SESAR Multiple Remote Tower for Eelde & Beek

As part of Single European Sky ATM Research (SESAR) activities, NLR and their consortium partner Air Traffic Control the Netherlands (LVNL) successfully completed a series of live trials and simulation exercises using the NLR ATC Research Simulator (NARSIM) in a special configuration for the LVNL Remote Tower Centre (RTC) located at the LVNL premises at Schiphol. The NARSIM set-up showed the same 360-degree panoramic outside view in a 180-degree monitor arrangement that a Saab camera system provided for Groningen Airport Eelde (GAE), including the special RTC functionality of a Pan-Tilt-Zoom (PTZ) camera. This camera covered a much wider area of the airport and allowed zooming in on pre-defined positions or selected aircraft. The NARSIM set-up was used to familiarize controllers with the specifics of the GAE working environment that was set up in the Schiphol RTC. NARSIM was also used to develop suitable traffic scenarios for simultaneous simulation of a Maastricht-Aachen Airport (MAA) working environment in the RTC.





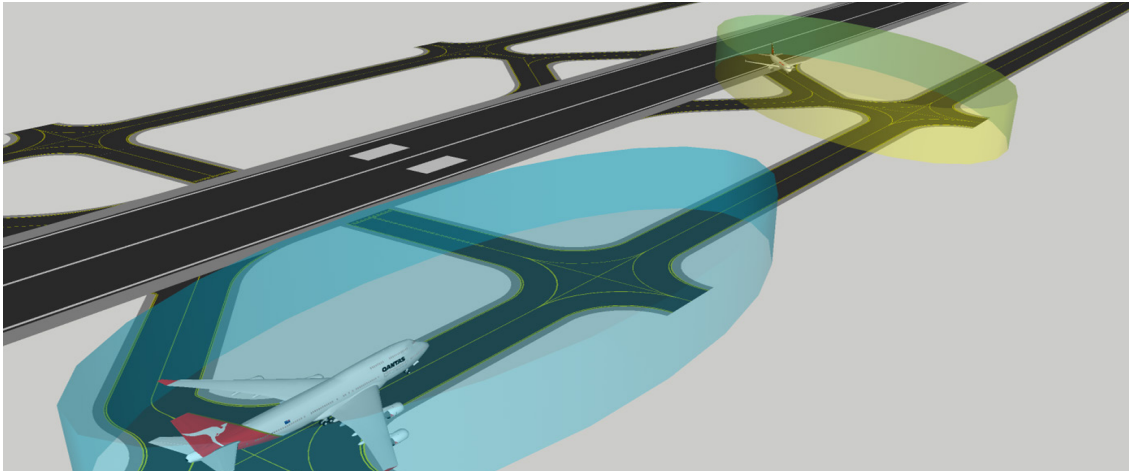
# Civil Airspace Integration of RPAS in Europe



The objective of the Civil Airspace Integration of RPAS in Europe (CLAIRE) project is to fly RPAS in controlled and non-segregated airspace in comparable treatment with manned aviation. The project comprised incremental demonstrations, working from real-time simulations on the NARSIM simulator to live-trials. NARSIM Tower and Radar were coupled to simulated the airport and TMA environment and traffic, while NATS controlled the en-route airspace. NARSIM was also connected to an external Thales RPAS simulation environment and ground control station. Different scenarios were simulated such as a loss of datalink with the RPAS, engine failures and communication failures to evaluate procedures. Overall the simulation helped in evaluating operational procedures of RPAS from the airport to en-route.

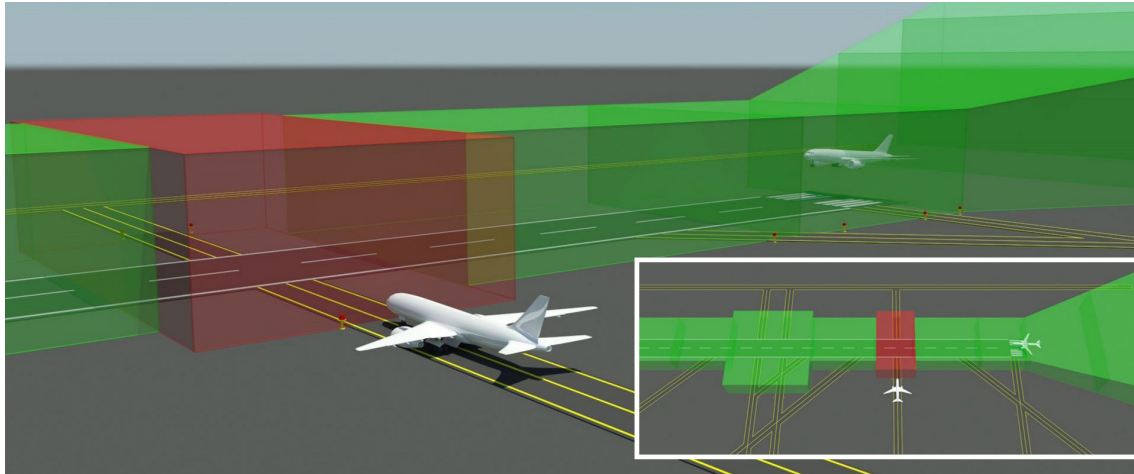
# Taxiway Conflict Detection tool

NLR developed a Taxiway Conflict Detection tool using probability trees to determine possible conflict pairs. The algorithm has been implemented in NARSIM Tower and connected to NASA Ames FFC for carrying out simulations of Charlotte Douglas airport by FAA apron controllers. The TCD tool was also used for validation at Schiphol Airport, where the main requirement of the by ATC provider was to include the controller in the taxi route selection process and use that information as an additional TCD input. NLR enhanced the existing aircraft state and airport layout dependent TCD prototype with planning information for Schiphol Airport. Variable Taxi Time Calculation and a traffic density estimator were added to determine the optimal taxi route for aircraft taking traffic density into account.



# Runway Incursions Alerting System Schiphol

NLR developed a Runway Incursions Alerting System (RIAS) for all runways of Amsterdam Airport Schiphol to enhance airport safety. The system is indicating violations of an area around the runway that protects aircraft that are about to land or take-off. To come to the end result the concept development, prototyping and validation was all done on NARSIM Tower. Subsequently NARSIM tower was used as platform for integrated system testing before the final system was installed at Schiphol. The RIAS system works under all visual conditions and includes audio and visual alerting and was used by Dutch ATC LVNL. Visual alerts are shown to the air traffic controller using bubbles as part of the Advanced-Surface Movement Guidance and Control System (A-SMGCS) system. Alerts also appeared in the Radar screen of the approach controller.



# Virtual Block Control

NLR developed enhanced Virtual Block Control for Milan Malpensa Airport during low visibility conditions. Instead of working with traditional physical stop bars, the virtual block control concept makes use of virtual stop bars, which enables multiple aircraft to be within one block during low visibility conditions, enhancing capacity. Safety nets are added to the concept in the form of Runway Incursion Alerting, Virtual Stop Bar violations and route deviation alerts. The system works with digital clearances or instructions for push-back/start-up and taxi (D-Taxi). NARSIM Tower was used for the concept development, prototyping and validation of the system by air traffic controllers from ENAV. Also NARSIM Tower was connected with the Alenia cockpit simulator for integration of the Virtual Stop Bars on the pilot navigation display.





# Wintertraining

NARSIM has facilitated a large-scale (55+ actors) winter exercise for Schiphol Airport three times. The scenario comprises sudden unexpected snowfall for operational airside representatives from Amsterdam Airport Schiphol, KLM, LVNL and the meteorological institute KNMI. The goal of the training is to minimise impact of unexpected snowfall on the daily operation while maintaining safety. It focusses on enhancing collaborative decision making (CDM) between team members and teams. For this exercise NARSIM Tower and Radar have been coupled for an integrated simulation. All involved parties were very satisfied with the exercise and simulation environment and are now prepared for any upcoming though Dutch winters.

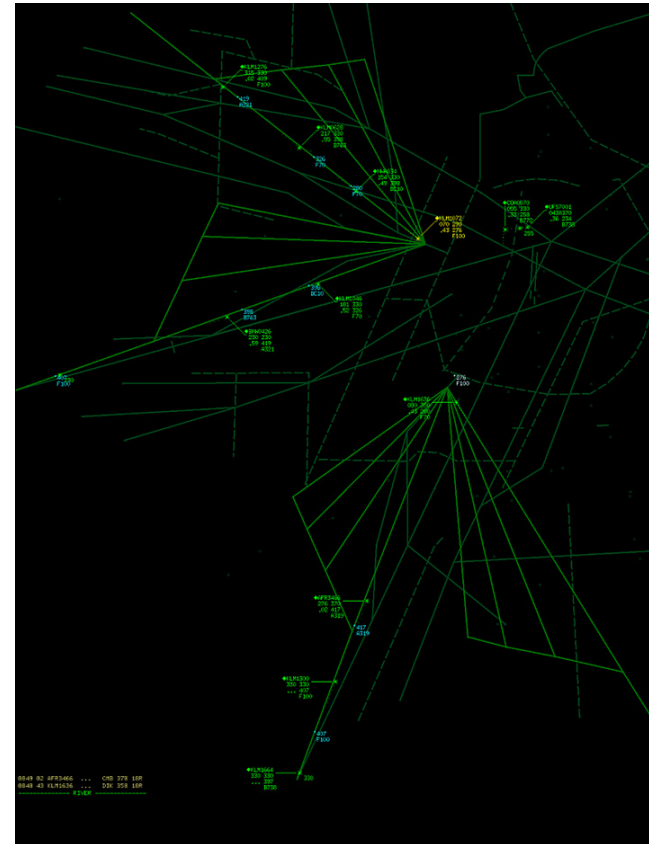


# Traffic Merging in TMA

One development which could help to reduce noise pollution further for those living near Schiphol Airport is conducting Continuous Descent Operations (CDO) along fixed approach routes. With a view to introducing these fixed approach routes to the busy day-to-day operations at Schiphol, a traffic merging concept study was performed by NLR. This study involved inventorying solutions for supporting air traffic controllers in efficiently merging two or more traffic flows on fixed approach routes into a single flow.

The NLR's CORADA (Converging Runway and Approach Display Aid) was developed and validated using NARSIM. A CORADA solution was chosen based on spacing using a ghosting concept. This concept is similar to the MITRE Relative Position Indicator (RPI). The ultimate decision on implementation of the ghosting concept will be taken by LVNL. This decision needs to be as simple as possible (without integrated wind information) and including the option of keeping radar screens free from too much information, e.g. by probing, switching ghosts on and off.

As a continuation trial, the interval management simulations are currently taking place at NARSIM.



# NLR in brief



One-stop-shop



Global player with  
Dutch roots

>100

100 years young



Amsterdam, Marknesse,  
Schiphol



Innovative, engaged  
and practical



For industry and  
government



For civil and  
defence



632 employees



€ 73 M revenue



75% Dutch, 21% EU and  
4% international



Active in 29 countries



Extremely high  
client satisfaction

# About NLR

## 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 is well known for its skills and expertise in the area of designing new airspace and routes, developing new operational procedures and specify necessary equipment for the implementation of air traffic control systems (ground, tower, approach, area, en-route,); airport airside operations, expert support on environment, safety, training and human factors.



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