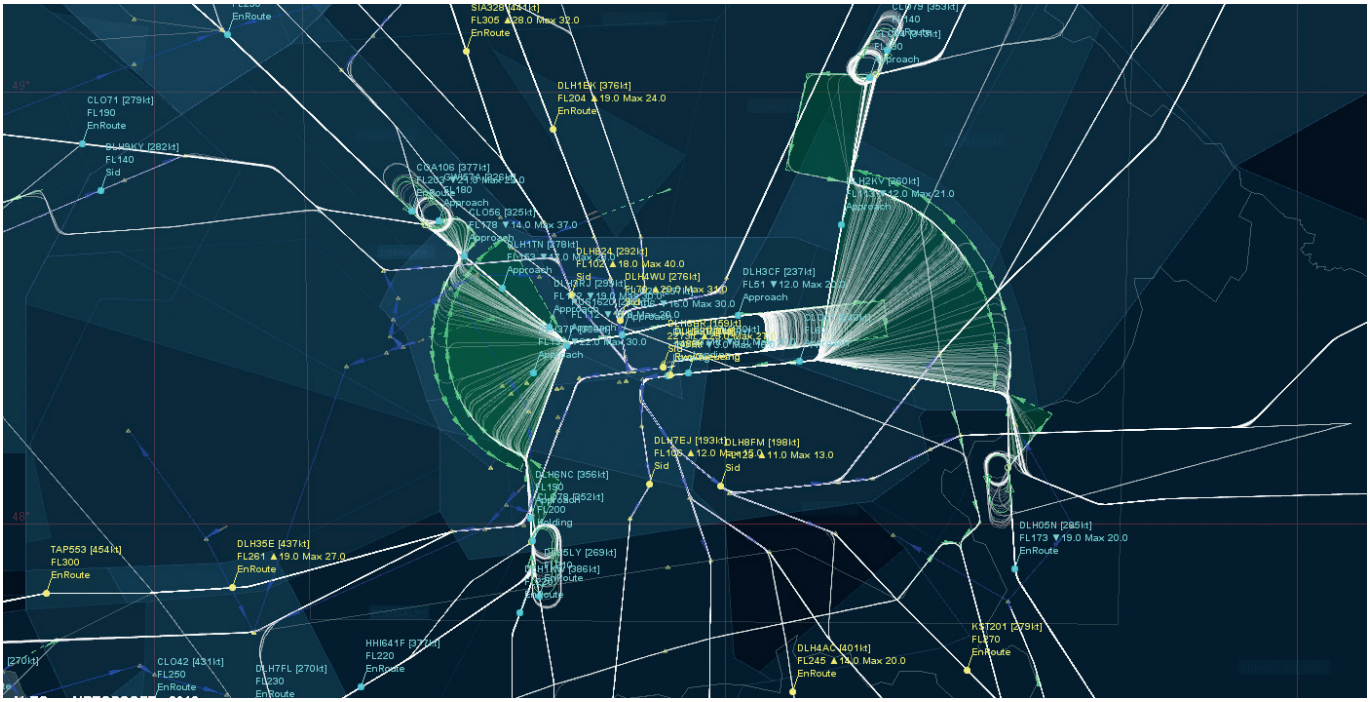


EMBRACE THE GROWTH

The latest fast-time simulator can help ATC meet the challenges of future air traffic growth with insight provided by modeling and simulation

By Gustavo Mercado and Pier Ferraris, product managers, Airtopsoft 'a Transoft Solutions company'

Air traffic is bound for continued growth in the foreseeable future. Long term growth factors such as further globalisation in business and an increase in tourism will outweigh potential disturbances such as an occasional economic crisis or terrorist attack.

Last year, Eurocontrol published the fifth study of the "Challenges of Growth" series of reports. The reports identify and quantify the related airport and airspace capacity challenges for Europe until 2040. The latest report describes four scenarios of growth with the moderate "regulation and growth" scenario as most likely, with traffic in Europe expected to grow to just over 16 million flights in 2040 from around 10 million in 2008. Current airport capacity plans are addressing this growth, and yet they will fall 1.5 million flights short of demand. In addition to that, the report mentions that a typical Summer day in 2040 will have 16 airports as congested as Heathrow is now, pushing the network to its – already stressed – limits. Climate change will also play a key role, as the quantification of the environmental impact of air traffic has become a recurring topic among regulators and operators. Albeit the aviation industry started addressing the need for adaptation, there is much to be done.

Fast-time simulation

Fast-time simulation is and will continue to be one of the most cost-effective technologies for analysing and communicating airport capacity plans and airspace redesign. Within a short time and with minimum staff and equipment requirements, it enables the modelling and analysis of airspace and airport environments, including the work of air traffic controllers. After calibration, fast-time simulation models can provide a reliable evaluation of new solutions and alternative configurations, allowing airports and Air Navigation Service Providers (ANSP) to handle uncertainty.

AirTOP software

AirTOP is as an advanced worldwide-accepted airspace and airport fast-time simulation tool that helps airport operators, ANSPs, airlines and other aviation actors to measure operation performances, assess traffic complexities, estimate air traffic controller workload, and evaluate future scenarios. The modular nature of the software allows organisations to select the module configuration that best fits their needs and extend this configuration as the circumstances require. These modules are split into two functional areas; airspace and airside. The available airspace modules are called "En-Route", "Flow Management", and TMA/TRACON, whereas airport operations are simulated with the "Airside Aircraft" and "Airside Vehicle" modules. An additional module called "Runway Capacity Analyzer" targets the runway performances adopting a Monte Carlo simulation approach. An extensive list of users worldwide has been able to experience that the simulations

Left: PointMerge Approach Modeling in the AirTOP software
Right: AirTOP supports complex ATM Fast-Time Simulation
Below: Airport Airside modelling and simulation is possible using Transoft's AirTOP

produced by AirTOP's airspace and airside modules are accurate and reliable.

En-Route

The En-Route module takes care of the air traffic simulation between airports. Elements such as waypoints, Air Traffic Services (ATS) routes with altitude and/or speed restrictions specified per segment and in both directions, Air Traffic Control (ATC) sectors and dynamic sectorisation concepts, Flight Level Allocation Scheme (FLAS) areas, radar controller tasks and the dynamic allocation of a radar controller to a given sector, can all be modelled one at a time or imported from external data sources. The routing concept in AirTOP avoids the duplication of traffic paths for aircraft flying to or from the same destination while providing a simple and fast way to create an En-Route traffic simulation model.

This simple setup can also be escalated to a more complex implementation. The module supports the creation of flight routes that combine the use of waypoints and airways or ATS routes. The ATS routes concept enables the user to create bi-directional airways, with open flight levels specified by segment. In addition to that, sectors, control centres, and regional airspaces are also supported. Letters of agreement, context-based altitude changes, and dynamic re-routing can be modelled with rules that are associated with specific controllers. This association enables accurate workload estimations. Furthermore, the conflict detection and resolution rule base provided with the module is user editable.

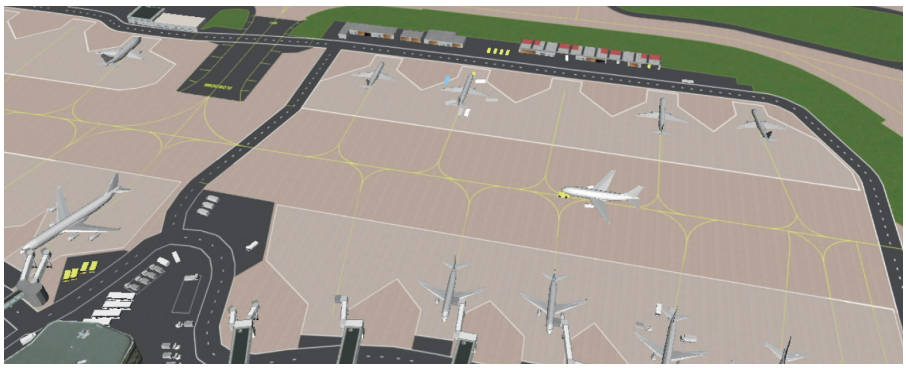
Aircraft movements and controller tasks generate exportable report events that can also be used offline to estimate controller workload with other methods. This estimation can also be performed online with a customizable workload model that allows the association of work durations to specific events. Built-in statistics per sector, flight, airport, or runway can be easily queried and exported. Result statistics can also be aggregated from multiple runs with random variations.

Flow Management and 4D trajectories

The Flow Management module analyses and optimses the flow of aircraft including Demand/Capacity Balancing (DCB). Various flow management strategies can be modelled such as queuing at sector entry, sector re-configuration or level capping.

Arrival Manager (AMAN) and Traffic Management Advisor (TMA) configurations can be modelled. The AMAN/TMA can anticipate changes in touchdown demand and build an optimal and feasible arrival sequence that respects minimum separation criteria. Multiple AMAN/TMA running together on different runway systems is supported. En-Route queuing systems and AMAN/TMA can publish En-Route time constraints. Strategies to achieve the given target times or separations include speed control, En-Route path stretching, holding stack, and delay at gate or take-off. The module supports the modelling of planned 4D trajectories, which are estimated before and during the simulation. Planned 4D trajectories are updated dynamically during simulation in response to controller actions, unexpected delays, or DCB measures. The behaviour of network/flow management actors can be defined and negotiations between actors can be modelled with user-defined rule bases which determine the chain of actors involved in a negotiation. The workload associated with negotiation and flow management can be simulated dynamically and customized for each actor.

Planned and unplanned delays are measured accurately per flight and can be logged at different times. The difference in flight duration, flight distance, and fuel burn between the last planned 4D trajectory before take-off and the final 4D trajectory updated during flight can be logged. Airspace, waypoint or airport entry and occupancy count can be plotted for all types of planned 4D trajectory.

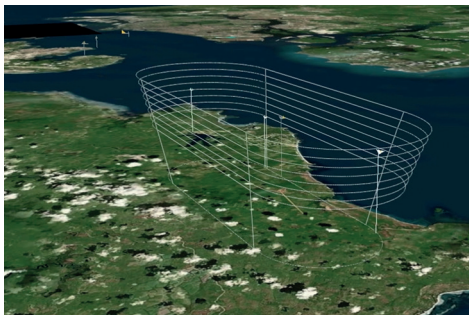


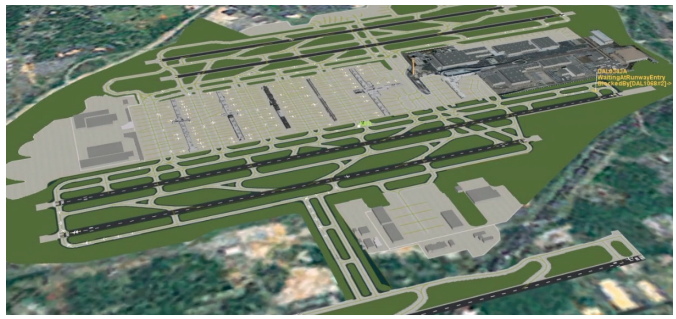
TMA/TRACON

The terminal maneuvering area and terminal radar approach control (TMA/TRACON) module supports all critical approach and departure structures for airports. It simulates all related aircraft movements in the airport TMA/TRACON airspace as well as the required departure/approach controller tasks. Linking all airport processes and events with ATC on the surface and in the terminal area, such as advanced AMAN and DMAN (departure manager) and emulating ATFCM and CDM (collaborative decision making) events, the module will help the busy airport to understand capacity issues and underlying delay factors. En-Route domain objects, runways, standard

Left: A rule-based holding management mode simulation produced by Transoft's AirTOP software

Right: A rule-based gate-to-gate simulation can be used to provide insight into airport capacity





instrument departure (SID), holding stacks, standard instrument arrival (STAR) and transition vectoring can be easily created and edited and the essential static or dynamic (rule-based) restrictions associated to these objects are supported, including speed/course/altitude restrictions along SIDs, STARs, manoeuvring areas on approach, rule-based departure/arrival separations, and wake turbulence separations. Actual track trajectory records can be imported from various file formats, and integrated filter functionality allows to derive transition vectoring areas with their typical speed and altitude restrictions, whether these are published or not.

The rule-based runway dependencies concept in the module lets users consider all of the constraints imposed on the arrivals and departures of one runway by those on another. These constraints includes the synchronization of departures and arrivals on crossed or parallel runways and the arrival of staggered mode operations. Separations can be made for any pair of runways. Simulated controller tasks (tower, departure, pick-up, feeder) use all static or dynamic restrictions and provide realistic departure and approach sequencing. Rule-based circuit/touch and go, as well as rule-based missed approaches, are supported.

Besides the two- or three-dimensional playback with satellite imagery or custom charts in the background, the module provides reports of controller workload. In general, workload is estimated dynamically and can be customized for TMA/TRACON and airport/tower controllers. The workload model can associate work duration to any event, such as TMA entries, for instance.

Airport simulation

The simulation of the aircraft movements and associated parking and other processes is taken care of by the Airside Aircraft module. It supports the rule-based modelling of parking/gate allocation, push/pull procedures, Taxibot/E-Tax operations, taxi flow control, runway entry/exit selection, single/multiple runway sequencing, runway crossing, turn-around management, de-icing procedures, ground metering and DMAN, dynamic runway direction change, amongst others. The Airside Vehicle module takes care of providing simulations for specific vehicle-related analyses, for example the assessment of service-road bottlenecks that could jeopardize the timely servicing of aircraft.

The Runway Capacity Analyzer module does not require extensive modelling and works with an isolated runway model including entries/exits and a simplified airspace component. It applies advanced data-analysis techniques to evaluate current or future capacity of the runway system, obtain optimized traffic sequences, or study the impact of fleet mixes, Level of Service (accepted delay), preferential flight treatment or other parameters.

The What If AnalyZer

WIZer (What-If AnalyZer) for area control centres (ACCs) is a module that uses the AirTOP fast-time simulation engine to produce detailed, up-to-the-minute forecasts of air traffic demand, traffic complexity, and controller workload. These forecasts can be used to provide decision support to supervisors and FMPs/Traffic Manager (Flow Management Position), by providing warnings when the entry count, occupancy, or workload/complexity of a sector is forecast to exceed some user-defined threshold. The tool offers further decision support by proposing ATFCM measures to balance demand and capacity and allows the user to produce "what-if" scenarios which present the results of such proposed measures by the system or by the user.

WIZer takes in input data in the form of flight progress messages, radar tracks, wind and storm forecasts, the current sector opening scheme and the current activated scenarios or regulation. The forecasts are displayed to the user in a graphical interface that highlights periods during which the demand is forecast to exceed capacity. The tool provides options to either reduce demand or increase capacity and displays the results of executing such measures on the updated forecast, allowing the user to perform interactive what-if analyses of the available options.

WIZer has been developed in close collaboration with DFS, Deutsche Flugsicherung GmbH, and the first operational installation of the tool was deployed in the Munich ACC in 2018. It is currently being rolled out to other ACCs in Germany, whilst several other ANSPs have discovered the operational advantages of WIZer and are following DFS in implementing the tool. ❖

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