The New Generation of Airpace and Ground Modeler

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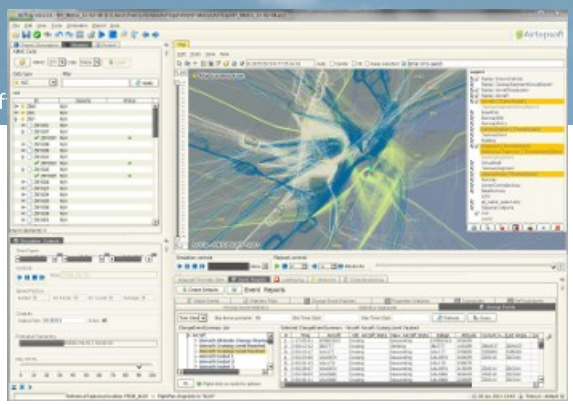


Key Benefits

Modular rule-based gate-to-gate fast time simulator,
En-route ATC and traffic flow management (DCB, AMAN),
TMA multi-airport runway sequencing,
Aircraft and airport handlers vehicles ground movements,
NextGen & SESAR concepts modeling,
Open and extensible using API.

AirTOpsoft
Air Traffic Optimization

Overview

Single graphical user interface

Simulation scenario editing and debugging are arguably two of the most time-consuming tasks when performing studies using fast time simulation tools.

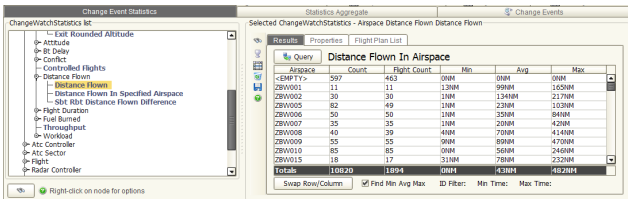
The AirTOp interface has been specifically designed to reduce the time needed to set up and debug simulations, in order to achieve faster results and better cost efficiencies. With its forward-thinking approach, AirTOp allows scenario editing, simulation execution, debugging, reporting and simulation analysis through one single sophisticated interface which includes highly interactive 2D maps and 3D views.

This approach makes it possible to instantly create, import or modify scenarios. It also enables users to rapidly assess any input errors or unwanted behaviors while executing the simulation and making corrections / modifications on the fly.

AirTop scenario data can also be **imported directly from external sources** including: FAA (ACE, PDARS, ETMS, OAG, DAI), TAAM, RAMS, DWG (background and airport layout), Eurocontrol (GASEL, ALL_FT) etc

Integrated reporting and result analysis

AirTOp provides all necessary report generation, visualization, filtering, recording and playback in order to make in-depth analysis of AirTOp simulations.



Reports (saved as ASCII csv files or exported to SQL databases) include 4D aircraft movements, ATC Sector occupation/entry/exit, controller task activation and workload, conflict detection/resolution, flight plan delays, ground delays and structure occupancies, flight plan phase duration, etc.

Integrated 2D Map and 3D Views

AirTOp uses a powerful graphical user interface featuring an easy-to-use integrated map-based application. This application contains full GIS capabilities, allowing flexible background display of scanned maps, aeronautical charts or vector data, weather data, satellite images and elevation data.

The multi-layered interactive 2D visualization features easy-to-use navigation controls as well as data creation and editing. A single click of the mouse allows the viewing of data entry on the map and on the information display simultaneously, paving the way for data modification and scenario editing.

Multi-agent Architecture

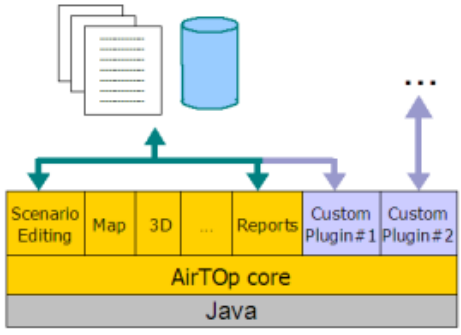
AirTOp has been designed as a multi-agent application to accurately capture all controller tasks and behaviors, as well as all concepts or objects they can interact with or manipulate. This unique feature ensures greater application robustness and more accurate simulations. It also gives Airtopsoft the capability to drastically reduce enhancement and delivery cycles, speeding up the development process.

AirTOp supports the modeling and rule-based interaction of radar controllers (En-route, TMA), airport controllers (Apron, taxi, tower, etc), aircraft operator centers (Airlines), and traffic flow managers (ATFM).

Extensive and customizable with API

The AirTOp development suite is a unique feature allowing AirTOp customers to enhance and/or customize the AirTOp fast time simulator. The API (Application Programming Interface) gives access to any data and their attributes at any time during simulation execution.

The development suite also features a customizable distributed data control plug-in, allowing the integration of AirTOp as a separate module of a physically distributed application over several platforms.

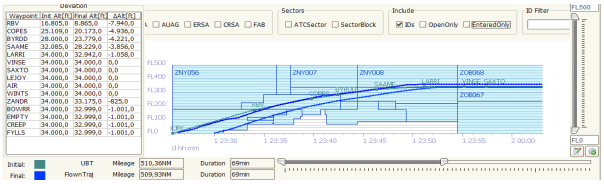


En Route Modeling

Scenario Definition and Modeling

AirTOp supports all key en-route structures and controller tasks, as well as all static or dynamic restrictions related to them, thus providing realistic en-route simulation.

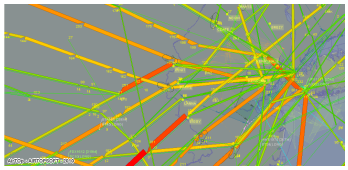
Waypoints, ATS Routes with altitude and/or speed restriction per segment direction, ATC Sectors and dynamic sectorization, FLAS areas, radar controller tasks and dynamic allocation of a radar controller to a sector, can all be easily defined by simply clicking on the map, or via the adjacent information display. They can also be completely or partially imported from external data sources.
The routing concept in AirTOp provides an easy way to **quickly create en-route traffic simulations**, avoiding duplication of traffic paths for aircraft flying to or from the same destination. It supports the creation of flight routes mixing waypoints and airways / ATSRoutes.The **ATSRoutes** concept allows the creation of bi-directional airways, with opened flight levels specified by segment.



Vertical view comparing actual flown trajectory (based on radar track record, demand and simulated. X axis can be based on time, duration, distance. View can also show altitude or distance difference between all 4D trajectory types.

Modeling of **sectors** (elementary or combined, **military**), **control centers** (with their associated **sector opening schemes**, **entry and occupancy capacities**), as well as regional airspace (**NAS**, **ECAC**, ...) is supported.

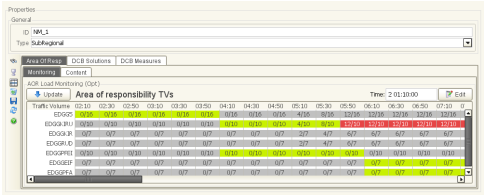
Accurate bi-directional route segment usage count (New-York TMA). Comparison between actual (radar track record based), demand and simulated.



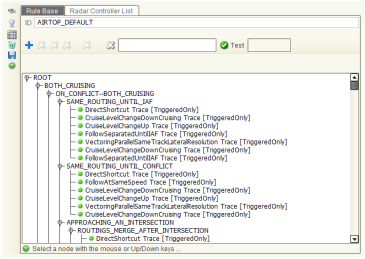
Letters of agreement (departure or arrival altitude/speed restrictions), context-based altitude changes, dynamic re-routing to avoid overloaded or closed sectors (military or weather), ..., can be easily entered into the scenario using user-readable rules associated to controllers. They can then be realistically simulated.

Load monitoring and DCB (Demand Capacity Balancing)

The load monitoring tool can dynamically update sector, airspace, waypoint or airport entry and occupancy count ahead of simulation time. Entry / occupancy count is calculated for different rolling periods in a horizon defined by the user. Entry / occupancy load exceeding given capacity can then be anticipated and assessed by rule conditions.
This makes it possible to detect and anticipate capacity problems, then model and test different strategies to solve them. Strategies include queuing at sector entry (entry at target rate), sector re-configuration, re-routing and level capping.



Airspace entry count monitoring per rolling user-defined periods ahead of simulation time



Conflict detection and resolution by editable rule base

The rule base includes resolution strategies (stop climb/descent, vector parallel/behind, cruise level change, earlier descent, follow at same speed/descent rate, shortcut etc) that can be customized by the user, taking into account the nature of the potential conflicts detected by the simulated radar controllers (conflict type, relative position of aircraft (highest, slowest), destination of aircraft, routing merging or not, distance to TOD, resolution maneuver feasible in sector, etc).

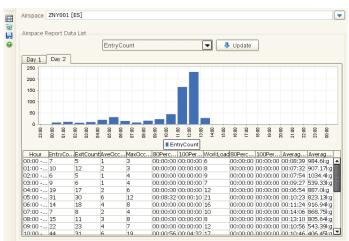
User-editable rule base for conflict resolution

Reporting

Aircraft movements and controller tasks, including conflicts detected and resolutions applied, conflict resolution demand, sector movements/entries/exit, flight events etc, generate **exportable report events** that can be used off line to realistically calculate the controller's workload.

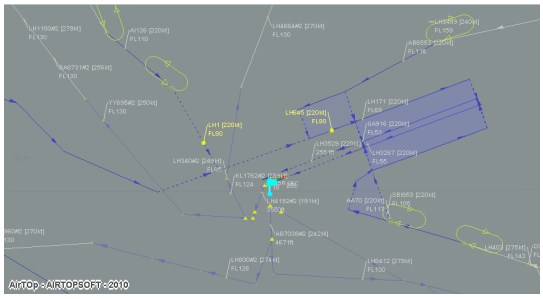
Controller workload can also be calculated dynamically in a user-customizable way. The workload model can take into account any event, and associate work duration to each one. It can also take into account monitoring activities of flights with any given attitude (climbing, cruising, in approach, holding etc).
The work duration associated to event handling (e.g. sector entry in climbing, altitude change clearance etc) can be split into generic user-defined activities (radio com, monitoring, conflict resolution etc). Duration spent per event and per activity can then be logged per rolling hour.

Built-in statistics per sector, flight, airport, or runway can be easily queried and exported (**Excel file**, **SQL databases**). Result statistics can also be aggregated from multiple runs with random variations



Airspace & sector report example: time distribution (rolling hour) of entry/exit count, average/max occupancy, average flown distance/duration/fuel burned in airspace, controller workload etc

TMA Modeling



Rule-based departure and approach sequencing between dependent runways of single or multiple airports (New-York metro and Frankfurt)
Approach sequencing combines speed control, vectoring, holdings tacks and staggered operations

Scenario Definition and Modeling

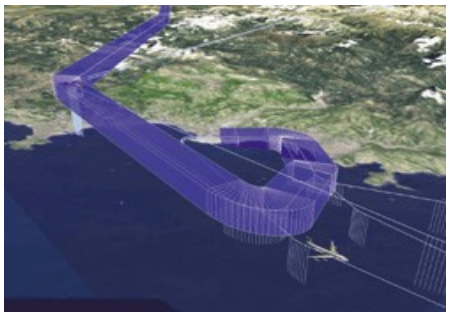
En-route domain objects, **runways**, **SIDs**, **holding stacks**, **STARS** and **transition vectoring** can be easily created/edited directly on the map, or using the adjacent information displays.

AirTOp supports all key static or dynamic (rule-based) restrictions associated to the above objects. These include **speed/course/altitude restrictions** along SIDs, STARs, maneuvering areas on approach, rule-based departure/arrival separations, wake turbulence separation, etc.

AirTOp can **import actual track trajectory records** from various file formats (Stanly, FAA PDARS, ...). Using the built-in styled and filtered trajectory display and playback, as well as vertical view and virtual walls, the AirTOp user can derive transition vectoring areas with their typical speed and altitude restrictions, whether or not they are published.

Multi-runway sequencing

The **rule-based runway dependencies** concept of AirTOp lets users take into account all constraints imposed on the arrivals and departures of one runway by those on another. This includes synchronization of departures and arrivals on **crossing or parallel runways** and arrival **staggered mode operations**. Separations (dep after dep, dep before or after arr) can be made for **any pair of runways**. They can be expressed as distance or duration, at runway lift off or start takeoff roll, for any combination of aircraft type, sid, sid group, departure fix, departure fix group, navigation equipment etc.



Simulated controllers tasks (tower, departure, pick-up, feeder) use all static or dynamic restrictions, and provide realistic departure and approach sequencing.

AirTOp also supports **rule-based circuit/touch and go**, **rule-based missed approach,** as well as **point merged procedures**.

Flow management, AMAN

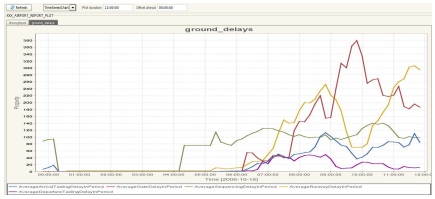
AirTOp can model and test different controllers strategies and/or planning systems to be used to manage traffic flow before entering the TMA and/or inside it.
The **flow constraint propagation** enables the modeling of controllers cooperation and negotiation inside the TMA to regulate the flow from TMA entry to touch down, considering required runway separation and configuration (e.g. staggered mode).
The **AMAN** modules enables the modeling and testing of different AMAN planning system setup, to pre-sequence en-route traffic before entering the TMA, based on precise planned runway touch down sequence. This module also enables the modeling of different strategies to meet AMAN requested en-route target times (at IAF and/or longer horizons). Strategies include mixing of speed control, vectoring, holding, and target take off time at departure airport.

Reporting

2D/3D filtered and styled playback can be displayed on top of maps and satellite data.

Controller workload can be simulated dynamically, and can be customized for for both ATC and airport/tower controllers. The workload model can associate work duration to any event (e.g. TMA entries, vectoring/speed/holding control, landing/departure clearances, ...). It can take also into account the monitoring of flight activities of all types (taxiing, stopped at crossing/stand-off, waiting for clearance etc).

Filtered (altitude) and styled display of New-York metro actual and simulated trajectories

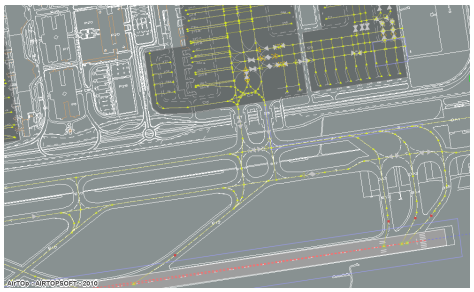


Built-in plotting of airport delays (rolling hour) comparing arrival gate/en-route/holding/sequencing delays with departure gate/taxi/runway delays, after modeling new runway separations and AMAN

A **customizable event log** can be easily created by the user and exported to **Excel** files or an **SQL database** for external specific analysis. Events can be related to any action taken by a controller (see above) or an aircraft (start takeoff roll, liftoff, runway touch down, runway exit, runway crossing reach, arrival at gate, start push back, start engine, start taxiing/runway crossing/lining-up etc). Each event can be logged, together with information related to the current status of the aircraft (aircraft type, airline, landing/departing runway, speed/attitude, departure/arriving/long term allocated parking position, aircraft/airport delays, ...).

Ground Modeling

The AirTOp ground module models air side ground traffic. Realistic, detailed models of airport ground layout can be built, supporting airport design or air traffic simulation. It can be used as a stand-alone application, and is also integrated into the AirTOp framework, making it possible to combine it with the other AirTOp modules and providing complete terminal-to-terminal simulation capability.



Munich ground layout creation using imported and geo-referenced Autocad DWG chart

Scenario Definition

The import and **graphical editing tools** enable fast and precise designs of airport ground layout, **DWG or .pol layouts** can be imported, and/or **airport satellite images** or **charts** can be used as background to the map view.

AirTOp thus features all ground airport structures including runway entries/exits/crossings/stop bars, taxiway segments, gates, remote parking positions, long term parking positions, aprons, hangars, de-icing stations, and more, as well as all associated usage restrictions.

The powerful AirTOp rule-based engine lets the end-user easily define all typical **airport controller tasks**, such as **runway entry/exit selection and usage**, **runway crossing procedures**, **runway lining-up procedure**, allocation of **gates/parking positions/stand-off positions/hangars**, **flight plan connections and turnaround management**, **towing operations**, **de-icing procedures** (at gate or at dedicated stations), **re-routing**, **stop-and-wait**, **runway departure/arrival separations**, etc.

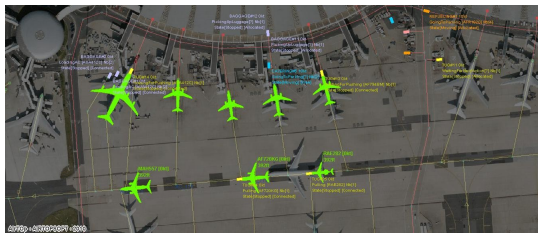
3D view of aircraft taxiing on Frankfurt airport, using AirTOp and custom 3D objects.

AirTOp also supports the modeling of **random gate delay**, Flow Management (**AMAN**), **target push back times, target takeoff times** and **Ground meetering procedures**

Airport Ground Handlers' vehicles

AirTOp also includes simulations of all common airport ground vehicles: tugs, catering vehicles, cleaning vehicles, fuel tankers, passenger buses, baggage tractors, container loaders.

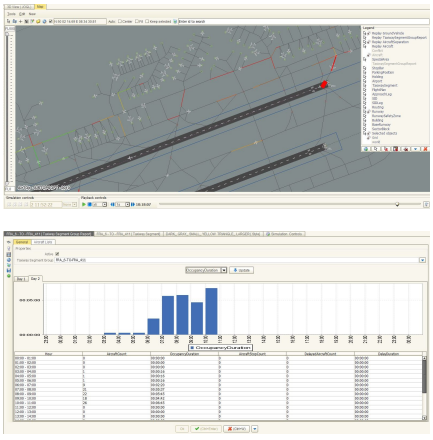
With or without tug modeling, AirTOp can be used to model and evaluate different tug usage strategies (e.g. push/pull, close to or far from the runway lining, enabling late(r) engine start), and to compare them, considering, among other things: fuel consumption, emissions, delays, duration of use and distance covered.



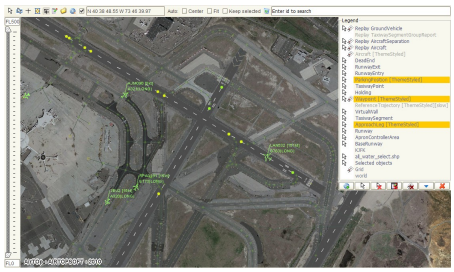
Aircraft and ground handlers modeling in Paris CDG airport reporting fuel consumption, emission, average, per service and total distance done per vehicle, handler and airport

Reporting

Ground delays are measured accurately per aircraft and can be logged at different times. Those ground delays include gate delays (because of passengers or late tug), taxi delays (dep/arr/total), departure runway delays, runway crossing delays (dep/arr/total). Delay calculation takes realistic aircraft acceleration and deceleration into account, as well as a user defined (and optionally random) ground speed which can depend on the aircraft phase and/or the aircraft location in the airport.
Delays can be then collected for all airports, for movement to/from one or more airport runway(s), or even for one or more portions of a taxiway.



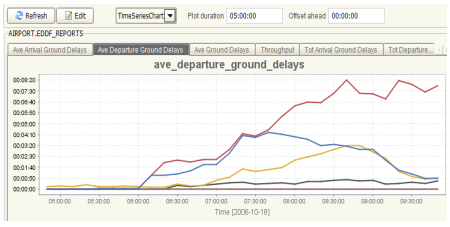
Playback of taxiway reporting (top) and distribution chart (bottom), including total delay lost and number of delayed aircraft



New-York JFK simulated track playback on top of satellite image screen shot geo-referenced using with AirTOp.

Built-in event plotting, and statistics query and display, are available and ready to use. Statistics can be reported at the level of an airport, a runway or group of runways, or portion(s) of taxiways.

Ground fuel burned and emissions of aircraft engines and APU can be accurately modeled for all phases of the aircraft (waiting for push back, pushing back, starting up and warming up engine, taxiing, stopped etc).



Built-in plot of airport KPIs (rolling hour) including throughput (gate, runway), controller s workload, as well as average/total delays compared with arrival en route/AMAN delays and TMA sequencing/holding delays

A new generation of airspace and ground modeler

Unique rule-based gate-to-gate fast-time simulator including:

En-route traffic modeling including editable conflict resolution rule base, letter of agreement modeling,

Advanced **TMA** modeling and multi-runway system sequencing,

Realistic **airport ground movements** including modeling of ground handlers' vehicles,

Flow management rule-based modeling including **AMAN** & **En-Route DCB** (Demand Capacity Balancing).

Multi-agent based modeling:
better capture of controller roles, tasks (ATC and airport controllers, flow managers, airport authorities, aircraft operator centers etc),
accurate and customizable measure of controller workload demand.

Integrated table and map-based application
scenario editing, project check & debug, simulation run and playback, reporting all in one single application,
external format import support,
Project management support.

Integrated reporting
includes hundreds of built-in reports,
allow custom reporting and plotting,
easily export reports into SQL database or csv files.

Open, modular and extensible
write custom extensions using the AirTOp Development suite,
reduces operational costs and enhancement delays.

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