Modeling Airside Operations at Major Airports for Strategic Decision Support

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Abstract

We discuss the construction and validation of a discrete-event simulation model to support planning for physical infrastructure and airside operating practice at major airports. The following figure illustrates the scope of activity encompassed by the model. Covered are aircraft movements from final approach to the airport; touchdown on the runway; taxiing to the gate for airlines, or to designated ramps for airfreight carriers and corporate aircraft; turnaround activities for continuing flights; pushback for departure; taxiing to the departure runway; and take-off with departure to a designated airspace sector.

System performance is affected by runway, taxiway and ramp layouts, terminal configurations, allocation of gates to individual airlines, the concentration of airlines’ flight schedules, air traffic control procedures for aircraft on the ground and in the air, adverse weather conditions, traffic backups at major airports, and changing regulations.

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connecting hubs, etc. Multivariate statistical analysis reveals how flight delays and ground movements of individual aircraft depend on: (1) time-period of the day, (2) day of the week, (3) runway used, (4) type of aircraft (light, medium or heavy), (5) airline, and (6) whether the flight is to or from a major hub airport.

We model the three domains (airline operations, airport facilities and traffic control) with Arena 14.7 by moving simulated aircraft through the network of staged queues – some physical, others conceptual. Ground movements are controlled by signals and routings that consider the capacities of ramps and taxiway segments. Aircraft arrivals are generated by a SAS (Statistical Analysis System) pre-processor and placed in conceptual queues at the final approach fix (FAF) for an active runway. Scenarios are defined by active runways for takeoffs and arrivals, weather in airspace sectors through which arrivals and departures take place, and conditions at major hub airports which may cause bunching of arrivals and traffic holds for departures. With a detailed log of simulated events (arrivals at the FAF, touchdowns on specific runways, arrivals at gates, departures from gates, and liftoffs for departure), we analyze simulated activity to estimate the effects of changes in infrastructure and operating practice on system performance. With this modeling approach, we strive for balance between highly detailed engineering simulations of airspace and airports with microscopic detail (which carry enormous overhead and require excessive time to perform) and operations research models designed for strategic optimization of parts of the system (which often ignore interacting elements of the system).

In our presentation, we discuss the integration of FAA flight data from air traffic control, airline gate data, and direct observations of ground operations to calibrate the simulation model. We illustrate the model-validation process and apply the model to estimate the impact of changes to airport assets and operating procedures under different traffic demands.

**Keywords:** Airport simulation; Decision support, Transportation infrastructure; Airport operations