Simulation and Visualization of Airside Operations at Detroit Metropolitan Airport (DTW)

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Introduction

Construction activities within the airside operations areas of an airport can considerably affect normal operations and safety of aircraft and other airport traffic. Cautious planning and implementation of alleviating actions are required to diminish the effect construction activities may have on normal airport operations. For this reason, studying airside operations and analyzing how they may interact with planned construction operations are vital in planning airport construction.

The presented work studies the extent to which airside airport operations can be accurately modeled and animated using general-purpose simulation modeling and visualization tools that are used in construction operations planning and design. The example investigates different airport operations scenarios depending on the meteorological weather conditions. The solution to the problem is described in detail using a simulation model developed in STROBOSCOPE (Martinez 1996) and a 3D animation created using VITASCOPE (Kamat 2003).

Background and Motivation

Previous research efforts have focused on studying aircraft runway and taxiway operations at airports. Macroscopic models such as the Airport Capacity Model (ACM) and Runway Delay Simulation (RDSIM) can be used to make policy decisions regarding the best runway operational practices (Odoni et al 2001). Microscopic models such as the Total Airport and Airspace Model (TAAM) and the FAA airport and airspace simulation model (SIMMOD) can handle detailed runway and taxiway operations but at an added detailed user cost (Odoni et al 2001).

Simulation models have also been developed to analyze the daily taxi and takeoff operation of aircraft at airports. For example, a model of the UPS Louisville Park assists planners in developing aircraft departure schedules that minimize taxi and ramp delay times (Ford et al 1999). The taxi simulation model was developed and validated using the simulation tool Arena.

However, existing airport models have some limitations. They typically can not model the interaction of operations in different domains, for example construction and air transportation simultaneously. They are usually designed to exclusively model landside and airside aircraft performance and behavior. In such situations, general purpose simulation and visualization tools such as STROBOSCOPE and VITASCOPE can be of significant help in modeling and studying how, for example, planned construction operations can interact with airside airport traffic.

Modeling Airside Operations Simulation at DTW

Detroit Metropolitan Wayne County Airport (DTW) is an international airport in Romulus, Michigan, located 20 miles southwest of downtown Detroit, Michigan. Figure 1 shows the general airport layout for DTW. The airport has six runways; four main parallel runways (4R-22L, 4L-22R, 3L-21R, 3R-21L and 4L-22R) and two crosswind runways (9L-27R and 9R-27L).

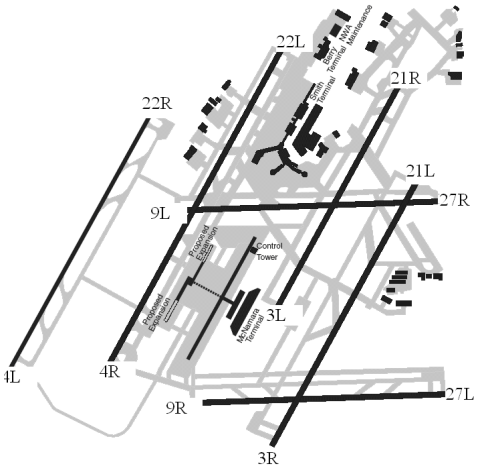


Figure 1: DTW Airport Layout

Figure 2 is an illustration of the two different runway configurations at Detroit Airport based on two weather conditions, Visual Flight Rule (VFR) and Instrument Flight Rule (IFR) conditions. Under VFR conditions, pilots can see far enough ahead of the aircraft and are permitted to approach, land, or take off by visual reference without relying on their instruments to fly safely, as is the case under IFR.

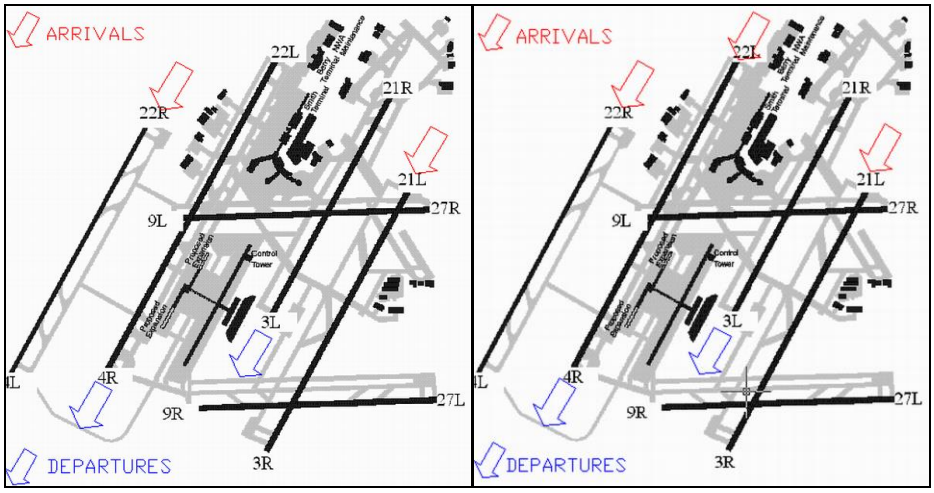


Figure 2: Arrivals and Departures under IFR (left) and VFR conditions (right).

Therefore, two different scenarios can possibly picture the possible modes of operations at Detroit Metro Airport under the aforementioned meteorological conditions (IFR and VFR conditions) and depending on the type of aircraft. Aircraft are classified according to the wake vortex criteria: light, medium and heavy. The first scenario operates under IFR conditions where two runways 21L and 22R process arrivals. Heavy, medium and light airplanes can land on any of these two runways. For departures, Runway 21R processes medium and light aircraft whereas 22L processes heavy ones. The second scenario operates under VFR conditions where three runways (Runways 21L, 22L and 22R) are used for arrivals and this applies to any aircraft type. Departure procedures meet the same requirements as under IFR conditions (scenario I). Only the first scenario operations will be presented.

Figure 3 shows the STROBOSCOPE model network that reflects the activities under scenario I. This network illustrates three major portions: the first one (in red) introduces airplanes to the system through arrival scheduler resource, the second (in green) models approach and landing of airplanes through resource *Plane* and the third one (in blue) models the minimum separations between airplanes in the common approach path through *Sequencer* resource. The same applies for the activities processed on the other runway (lower part of the network).

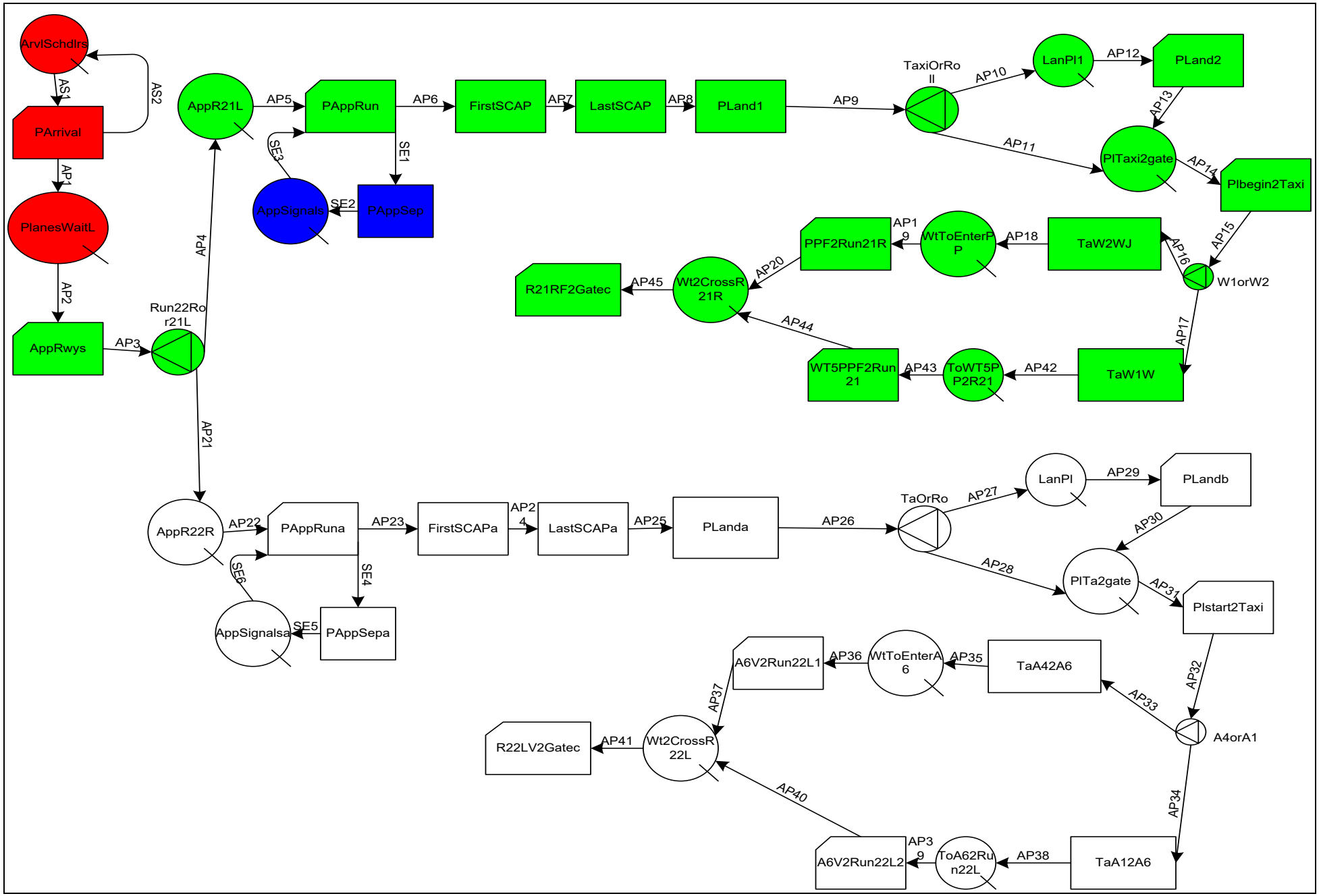


Figure 3: STROBOSCOPE Network for arrivals, scenario I

The model network that describes the logic of airplanes departing is defined in figure 4. This network illustrates two major portions: the first one (in red) introduces departing airplanes to the system through arrival scheduler resource and the second (in green) models departures of airplanes through resource *Plane.* Airplanes departing are generated independently of arrivals.

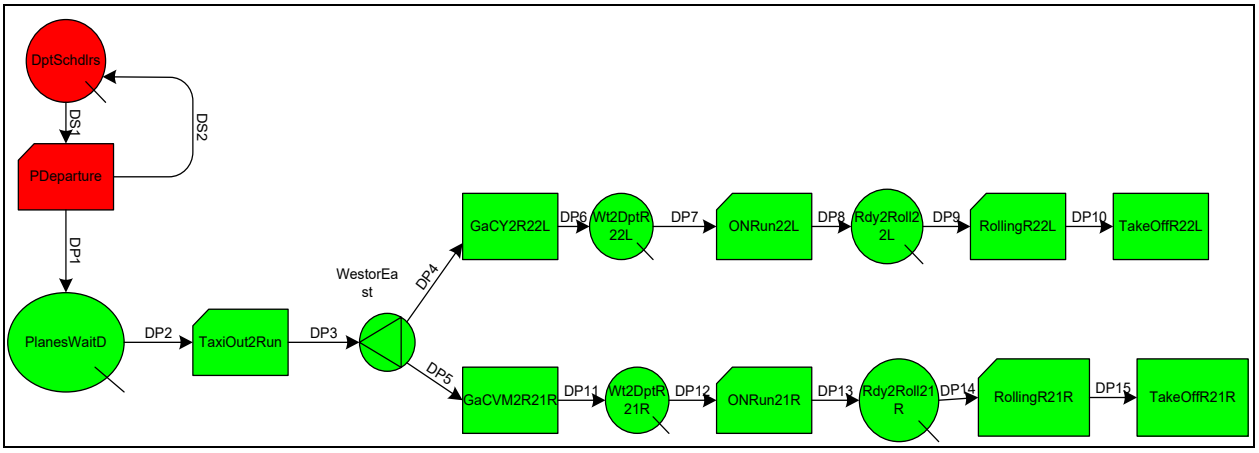
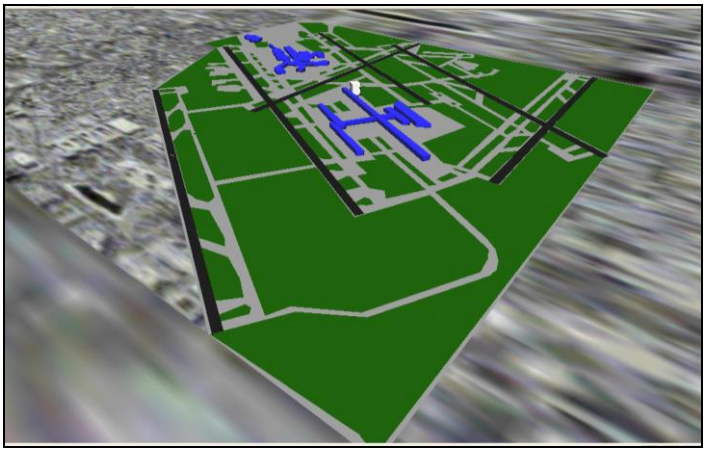


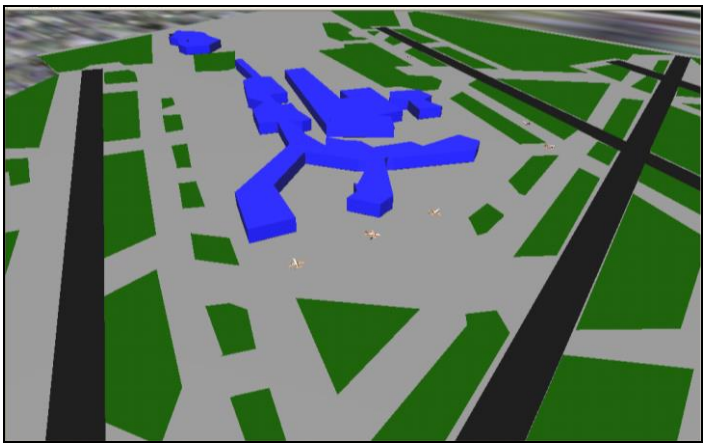
Figure 4: STRBOSCOPE networks for departures, scenario I

Operations Visualization at DTW

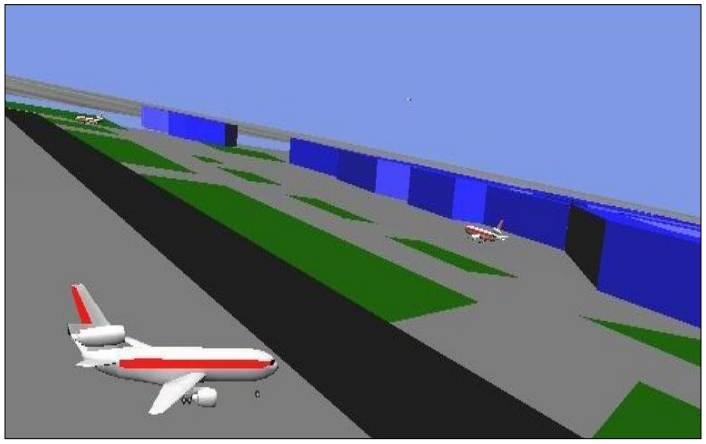
Visualization of simulated operations can be of significant importance in the verification, validation and accreditation (VV&A) of models. The STROBOSCOPE models created in this study were verified and validated using VITASCOPE (Kamat 2003). Figure 5 presents VITASCOPE animation snapshots of the animated operations.



Bird's Eye View of Detroit Metro Airport



View of Airport Operations around one of the gates



View of Airport Operations on Runway 22L (plane waiting to cross)

Figure 5: VITASCOPE Animation Snapshots

Conclusion

In this study, previous work on airports simulation and animation was examined, followed by the description of airport operations at Detroit Metropolitan Airport modeled and animated using general purpose tools typically used in construction simulation and visualization. Two scenarios based on different meteorological conditions were considered. The arrivals and departures under one of the scenarios (scenario I) were described and their respective STROBOSCOPE models were presented. Then VITASCOPE was used as a 3D animation tool to validate the models and ensure their credibility. More details on the presented STROBOSCOPE models and VITASCOPE animations under IFR and VFR scenarios are available in UMCEE Report 05-10 which can be found at http://pathfinder.engin.umich.edu/documents/Report-UMCEE-05-10.pdf.

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