Spot and Runway Departure Advisor (SARDA)

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SARDA Overview

SARDA technology highlights from NASA simulations

National Aeronautics and Space Administration

Spot and Runway Departure Advisor (SARDA)

www.nasa.gov
What are the problems?

• **Today’s Airport Surface Operations:**
  – Demand-capacity imbalance at major airports
  – Uncertainties in surface events
  – Lack of shared situational awareness and coordination

• **Consequences:**
  – Surface congestion and long queues
  – Excessive taxi delay and fuel/emissions
  – Poor predictability
SARDA Concept

NASA’s Departure Management Tool Based on Intelligent Surface Scheduling

- Builds an optimal runway schedule
- Generates spot release sequence and timing
- Determines when to push back from gates
SARDA as ATC Tower Tool

SARDA takes inputs from multiple sources and computes advisories for runway usage and spot release

- Taxi Predictor
- Runway Optimizer
- Spot Scheduler

**Local - Runway Sequence**

**Ground - Spot Release**

Surveillance → Taxi Predictor → Runway Optimizer → Spot Scheduler → Spot Seq & Timing

Pushback Time → Runway ETA

Arrival ETA → Runway Schedule
Spot release advisory shows spot release sequence & time, taxi route, departure runway queue

Handoff sequence to Local controller at departure queue

Traffic Mgmt Initiative
SARDA Local Controller Advisories

Active runway usage advisory shows sequence for arrival crossings (white) and departure take-offs (green)

Traffic Mgmt Initiative
Arrival advisories show sequence for crossing active runway and the taxi-to arrival spot

4/5/16
SARDA as Ramp Tool

SARDA takes input from multiple sources and computes advisories for gate pushback

Surveillance ➔ Taxi Predictor ➔ Runway Predictor ➔ Ramp Predictor ➔ Pushback Schedule

Today’s Operation:
• Paper ramp area map
• Paper flight strips

SARDA Ramp Tool:
• Electronic Flight strips
• Surface map & surveillance
• Pushback advisories

(Controller)
Wisconsin 3867 proceed up to south ramp
SARDA Ramp Controller Advisories

Ramp Traffic Console (RTC) displays SARDA advisories on ramp surface map.

- Departure list for east runway
- Departure list for west runway
- Gate advisories show pushback times, strips show spot
- Hold advisory w/ time-to-go

4/5/16
SARDA Benefits – ATC Tower Tool

- Reductions in departure taxiing delay (45% - 60%) and variability
- Reductions in fuel consumption (23 - 33%) and variability
- Consistent and accurate prediction of takeoff time
- Decreased controllers workload, less sensitive to the traffic load

Human-in-the-loop Simulation for Dallas-Fort Worth Airport (2012)
HITL - Ramp Controller Tool for CLT

- 27” touchscreen
- Virtual strips
- Ground radar information
- Dynamic SARDA pushback time advisories

Ramp Traffic Console (RTC)

Average Taxi-out Time

- Baseline
- Advisory
- Baseline
- Advisory

1.1 min reduction in Scenario 1 (10.5%)
0.8 min reduction in Scenario 2 (8.3%)
Gate Hold

gate_delay = actual_out_time – pushback_ready_time

Departures are held at gates longer in Advisory runs
1.53 min increase in Scenario 1 (99.7%)
1.29 min increase in Scenario 2 (75.4%)
Surface Congestion

Number of departures in movement area

Number of aircraft taxiing on the ground reduced (up to 4)
Real-Time Workload Ratings

Linear Mixed Model repeated-measures analysis:

- In Advisory runs, the FAA tower controllers’ ratings were reduced by 0.23 in 7 point scale ($p = 0.021$).

- The CLT ramp controllers’ ratings:
  - In South Sector: Advisory < Baseline
  - In East Sector: Advisory $\cong$ Baseline

![Graph showing CLT Ramp Controllers’ Real-Time Workload Rating (p = 0.008)]
Real-Time Workload Ratings

- In Advisory runs, the FAA tower controllers’ ratings were reduced by 0.23 in a 7-point scale ($p = 0.021$).

**CLT Ramp Controllers’ Real-Time Workload Rating ($p = 0.008$)**

- **East Sector**: Advisory ≅ Baseline
- **South Sector**: Advisory < Baseline

Linear Mixed Model repeated-measures analysis:

- “More difficult to manage the EDCTs with paper strips”
- “RTC wraps the information up all in one package”
- “Easier to plan with RTC”
- “Easier to visualize what is going on across the whole ramp using RTC”
- “Paper strips and maps should be put in a time capsule”
Summary and Next Steps

• SARDA provides a departure metering capability by optimally scheduling aircraft on airport surface.

• SARDA enables reduction in engine-on time by holding departures at their gates and provides better predictability.

• Human-in-the-loop simulation results of both ATC and ramp tools showed reductions in taxi delay, queue size, and fuel use.

• Currently, ramp controller advisory tool is used to provide the tactical surface scheduling capability for ATD-2 IADS technology demonstration.
Thank you!

For more information go to:
www.aviationsystems.arc.nasa.gov