Spot and Runway Departure Advisor (SARDA)

Dr. Yoon Jung
NASA Ames Research Center

Joint Workshop for KAIA/KARI/IIAC-NASA Collaboration
Korea Aerospace Research Institute, Daejeon, Korea
Incheon International Airport, Incheon, Korea
April 5-7, 2016
SARDA Overview

SARDA technology highlights from NASA simulations

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.

- **Surveillance**
- **Pushback Time**
- **Arrival ETA**

**Taxi Predictor** → **Runway Predictor** → **Spot Scheduler**

**Runway ETA** → **Runway Schedule** → **Spot Seq & Timing**

**Local - Runway Sequence**

**Ground - Spot Release**
### SARDA Ground Controller Advisories

**Spot release advisory** shows spot release sequence & time, taxi route, departure runway queue.

**Handoff sequence to Local controller at departure queue**

**Traffic Mgmt Initiative**

Arrivals going to ramp

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<table>
<thead>
<tr>
<th>Flight</th>
<th>A/C</th>
<th>Time</th>
<th>Runway</th>
<th>Taxi Route</th>
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<td>B772</td>
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</table>

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4/5/16
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.

### SARDA Local Controller Advisories

<table>
<thead>
<tr>
<th>Flight</th>
<th>Aircraft</th>
<th>Type</th>
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<td>EG</td>
<td>TRI/TYS</td>
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<td>A320</td>
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<td>EH</td>
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<td>AWE190</td>
<td>B737</td>
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<td>S63</td>
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<td>S10</td>
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<td>B752</td>
<td>CLR/MCO</td>
<td></td>
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</table>

### ATIS D

<table>
<thead>
<tr>
<th>Flight</th>
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<th>Location</th>
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<td>CTL</td>
</tr>
</tbody>
</table>

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SARDA as Ramp Tool

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

Taxi Predictor → Runway Optimizer → Ramp Optimizer

Surveillance
Pushback Time
Arrival ETA
Runway ETA
Runway Schedule
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

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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

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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

**Average Taxi-out Time**

<table>
<thead>
<tr>
<th></th>
<th>Taxi time (sec/aircraft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>600</td>
</tr>
<tr>
<td>Advisory</td>
<td>500</td>
</tr>
<tr>
<td>Baseline</td>
<td>600</td>
</tr>
<tr>
<td>Advisory</td>
<td>500</td>
</tr>
</tbody>
</table>

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 ≅ Baseline
Real-Time Workload Ratings

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

- 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