Spot and Runway Departure Advisor (SARDA)

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Topography of Airport and Surface Management

- 8 major airports – over $2B of excess fuel consumption over 2010 – 2030
- JFK – 15,000 hours of taxi delays per year
- BOS – 6,570 hours of taxi taxi delays per year

Surface traffic management complicated by:
- Uncertainties
- Lack of common situational awareness and coordination
- First-come, first served operations

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Intelligent Scheduling is the Key to Efficient Surface Management

SARDA is the NASA’s approach for solving this problem.

- Optimizes at a system level by minimizing overall delay
- Plans at a detailed trajectory level for aircraft movement (gate, ramp, taxiways, and runways)
- Uses a fast algorithm suited to real-time operations
- Accounts for departures and arrivals
- Connects the airport tower, en route facility, and the airlines
- Adaptable to other airports with different configurations
SARDA Concept

• Reduce taxi delay
• Reduce fuel consumption and emissions/noise
• Increase predictability

• Runway sequence & time

Tower

FAA/Airport

Ramp

Gate push-back Management

Aircraft
SARDA Scheduler Methodology

Tower (FAA)
- Runway Time Predictor
- Runway Scheduler
- Spot Time Calculator

Stage 1

Ramp (Airlines)
- Ramp Management System
- Push-back Time Predictor
- Push-back Time Calculator

Stage 3

Data Exchange

- Push-back times (scheduled/ready/actual)
- Airline constraints (e.g., priority)
- Target spot times

Handles uncertainties by frequent updates and freezing sequence for spot release and takeoffs/crossings

Spot Release Advisory

Runway Sequence Advisory

Push-back Advisory

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Recent Results
SARDA HITL Simulation

• Two major simulations for DFW (2010, 2012)
• DFW experienced controllers
• Data collected on performance and controllers workload
Taxiing Delay for Departures
(Actual taxi time – Unimpeded Taxi Time)

- Observed reduction in taxiing delay statistically significant
- Reduction in mean as well as variance
- Reduction in variability and increase in predictability
Overall Delay
(Actual Takeoff Time – Scheduled Takeoff Time)

- SARDA resulted in statistically significant reduction in overall delay ($p \sim 0.02$)
- Overall system delay reduced by an average of 1 minute per aircraft
Departure Taxi Fuel Consumption

- Observed reduction in fuel consumption: 23% average reduction in medium traffic and 33% average reduction in heavy
- SARDA reduces variability in fuel consumption
SARDA for CLT Ramp Operations
Charlotte Airport Field Testing (2015)

Source: US Airways

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Ramp Sector Controller Workstation
(Illustration Purpose Only)
US Airways-NASA Collaboration

• Goal - To develop and test a prototype DST for US Airways CLT ramp controllers for efficiency enhancement

• HITL simulations in three phases:
  – Phase 1: Building/testing core functions
  – Phase 2: Benchmark test
  – Phase 3: Follow-on tests

• Target dates:
  – Oct 2013  Completion of first HITL simulation
  – Aug 2014  Completion of benchmark test
  – Oct 2014  Completion of system integration at US Airways ramp tower
  – Sept 2015 Completion of field tests
Collaboration with DLR and NLR
NASA-DLR Collaboration

• NASA’s expertise
  – Surface decision support tool (e.g., SARDA)
  – Fast-time simulation and human-in-the-loop simulation capabilities
  – Flight deck based research on taxi conformance and trajectory-based surface operations

• DLR’s expertise
  – Research prototype of taxi management (e.g., Taxi Routing of Aircraft: Creation and Controlling (TRACC))
  – Arrival/departure management tools (AMAN/DMAN) and coordination

• Collaboration tasks
  – Compare surface management concepts between DLR and NASA
  – Develop a common integrated surface concept of operations
  – Evaluate DLR and NASA surface tools/algorithms in the other’s environment:
    • DLR models a US airport for testing TRACC
    • NASA models a German airport for testing NASA surface algorithm

Ground Controller Advisories by SARDA (Dallas/Ft. Worth Airport)

TRACC (Hamburg): a taxi route of a departure aircraft shown with speed advisories
NASA-NLR Collaboration

• Goal: Integrate NLR’s taxiway movement conflict detection technology with SARDA for a selected US Airport and conduct a HITL at NASA’s FFC.
• NASA technology – SARDA and high-fidelity HITL simulation
• NLR technology – Virtual Block Control (VBC) and Separation Bubbles (SBT)
• Collaboration tasks
  – Model a US Airport in NLR’s simulation environment and implement VBC in low visibility condition
  – Integrate NLR’s SBT in NASA’s Surface Management System (SMS)
  – Conduct HITL simulations at FFC and shadow mode tests
Questions?