https://ntrs.nasa.gov/search.jsp?R=20140009123 2019-08-31T20:15:09+00:00Z

Spot and Runway Departure Advisor (SARDA)

Yoon Jung
NASA Ames Research Center
September 16, 2013

View metadata, citation and similar papers at core.ac.uk
brought to you by CORE
provided by NASA Technical Reports Server

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

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

Tower

FAA/Airport

- Runway sequence & time

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

Ramp

Gate push-back Management

Aircraft

SARDA Scheduler Methodology

Tower (FAA)

Runway Time Predictor → Runway Scheduler → Spot Time Calculator

Stage1 Stage2

Spot Release Advisory

Runway Sequence Advisory

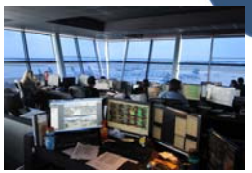
Data Exchange

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

Ramp (Airlines)

Ramp Management System → Push-back Time Predictor → Push-back Time Calculator

Stage3



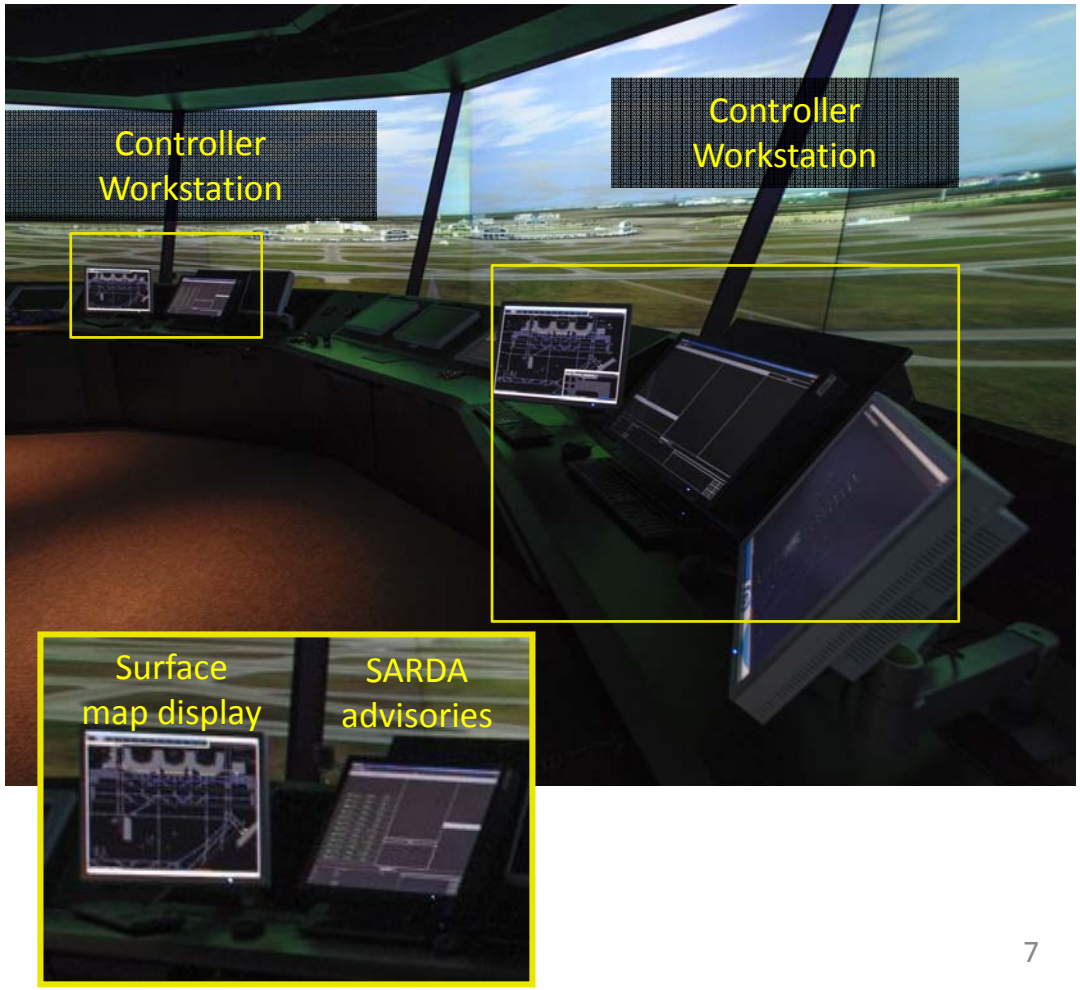
Push-back Advisory

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

Recent Results

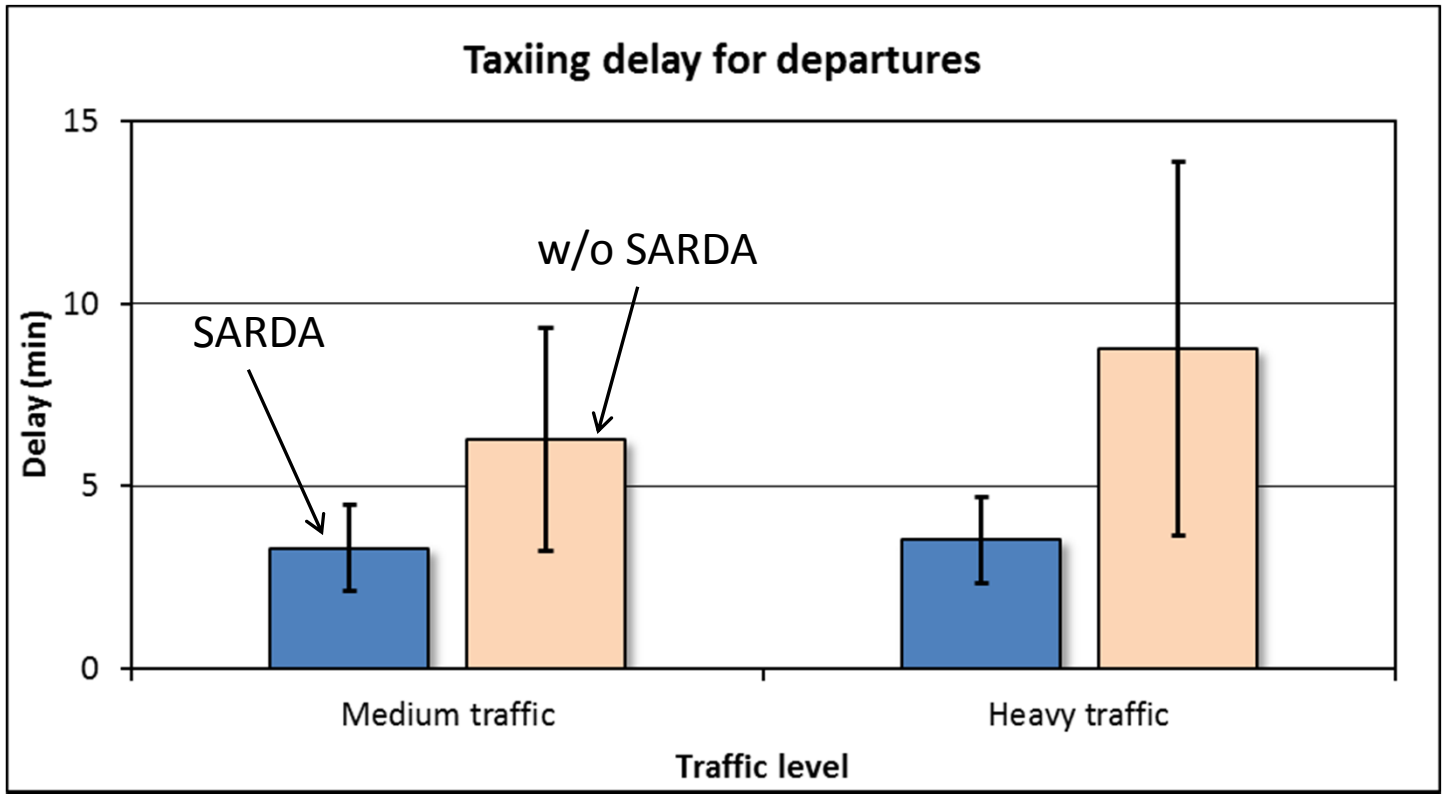
SARDA HITL Simulation

- Two major simulations for DFW (2010, 2012)
- DFW experienced controllers
- Data collected on performance and controllers workload



Taxiing Delay for Departures

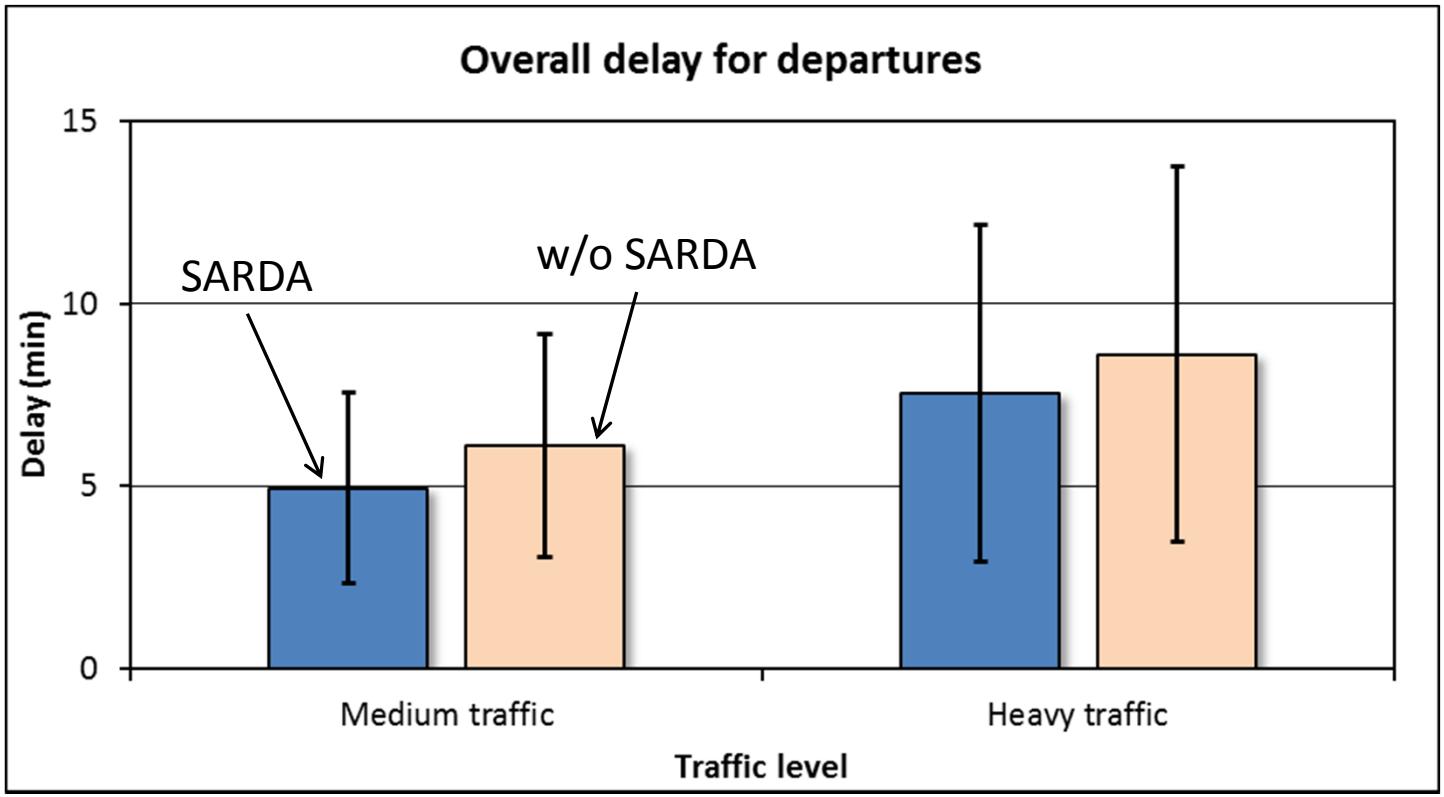
(Actual taxi time – Unimpeded Taxi Time)



- Observed reduction in taxiing delay statistically significant
- Reduction in mean as well as variance
- Reduction in variability and increase in predictability

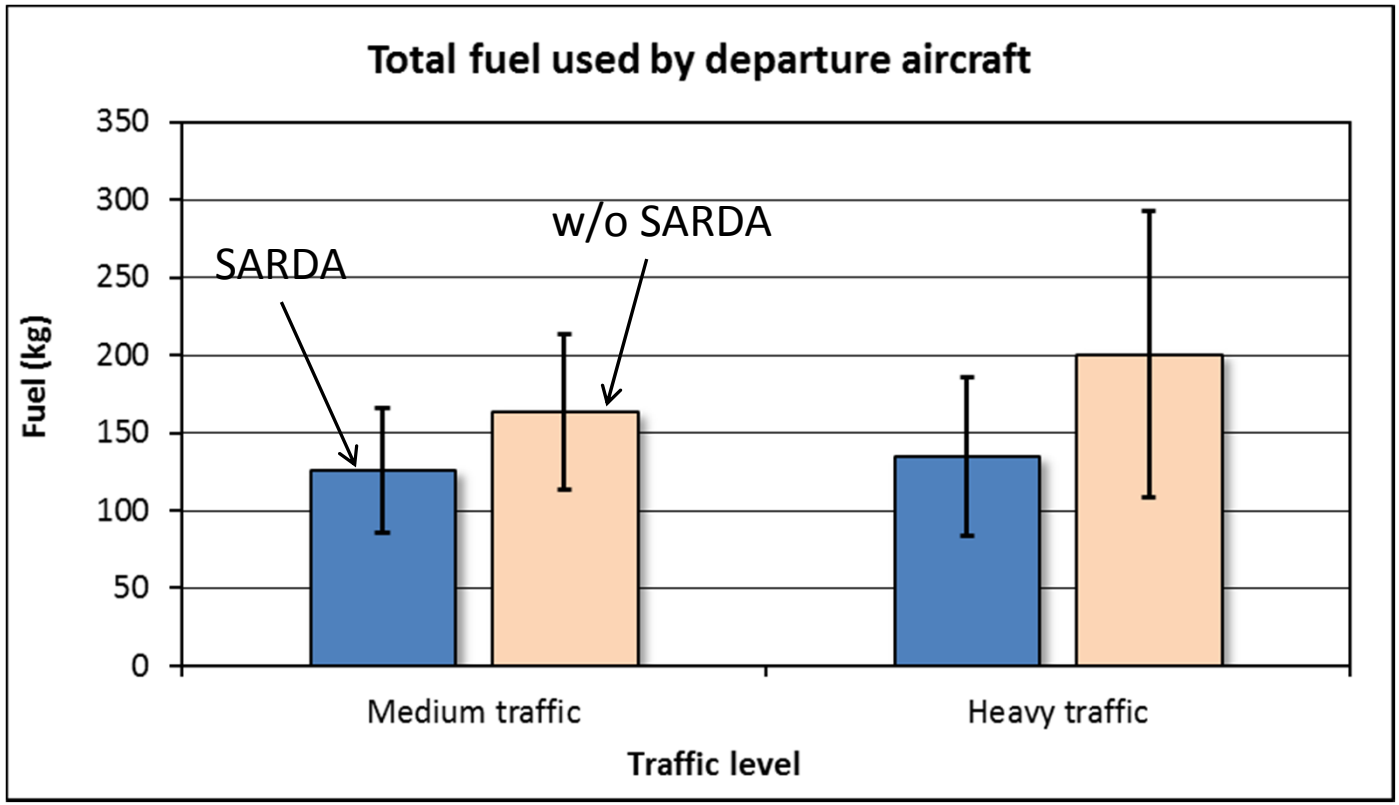
Overall Delay

(Actual Takeoff Time – Scheduled Takeoff Time)



- SARDA resulted in statistically significant reduction in overall delay (p ~ 0.02)
- Overall system delay reduced by an average of 1 minute per aircraft

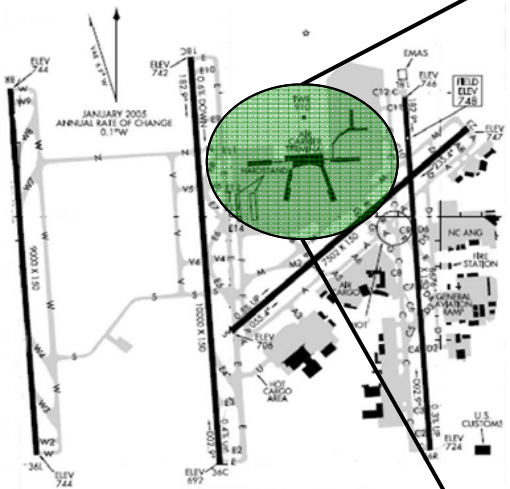
Departure Taxi Fuel Consumption



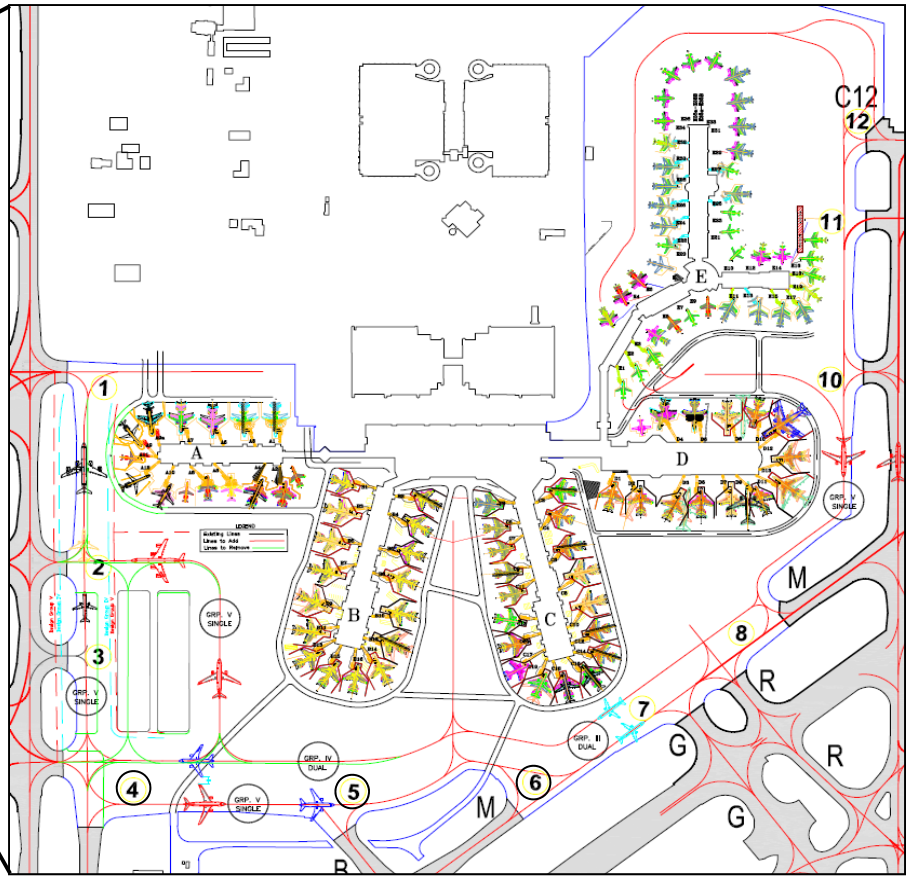
- Observed reduction in fuel consumption: 23% average reduction in medium traffic and 33% average reduction in heavy
- SARDA reduces variability in fuel consumption

SARDA for CLT Ramp Operations

Charlotte Airport Field Testing (2015)



Charlotte Airport



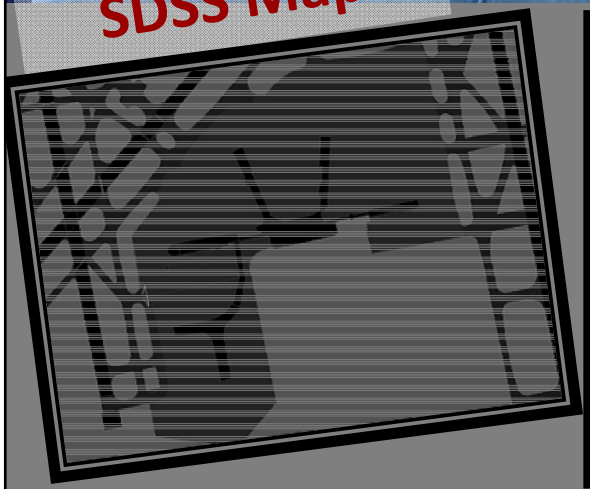
Source: US Airways

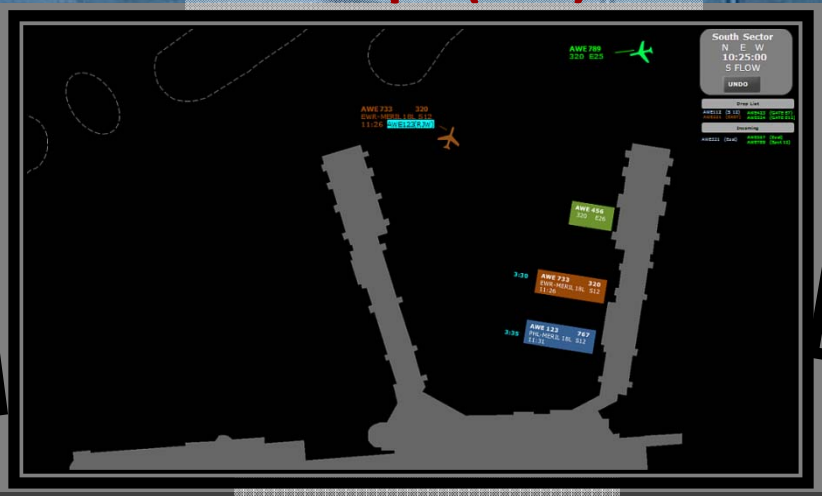
Ramp Sector Controller Workstation (Illustration Purpose Only)

SDSS Map

Electronic Flight Strips (EFS)

Gate Manager





(Touch screen)

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?