SARDA
Spot and Runway Departure Advisor

NASAfacts

Operational Challenges

Under current airport surface operations, the management of surface traffic is distributed amongst many different operators, who frequently lack a common set of information about airport conditions, and who often operate independently and reactively to the traffic conditions. Airport ramps (also called *aprons* or *non-movement areas*) are the areas outside taxiways and runways used for airplane parking, loading/unloading, refueling, and maintenance. Most large airports in the US have ramp towers operated by airlines, airports, third-party companies, or the local municipalities. Controllers in the ramp towers ensure safety and efficiency in ramp areas and oversee aircraft traffic as well as other servicing activities. The ramp controllers direct departures on a first-come-first-served basis.

The Federal Aviation Administration (FAA) manages the Air Traffic Control Tower (ATCT). Ground and Local controllers manage traffic on the taxiways and runways respectively, providing taxiway and runway clearances using a first-come-first-served policy, based on the order that aircraft arrive at the spots (the boundary between the ramp and the taxiways) and the runways.

There are two main sources of inefficiencies on the surface. One is peak traffic due to multiple aircraft with similar departure times. These aircraft call for pushback from their gates at around the same time and compete for limited resources (the taxiways and runways). This leads to many aircraft taxiing to the runway simultaneously, causing long runway queues and congestion on taxiways. Stop-and-go taxi operations resulting from surface congestion can potentially delay actual takeoff times and limit airport throughput.

The second source of surface inefficiencies results when relevant planning information is not shared between various airport surface stakeholders such as the ramp and ATCT controllers. Thus, decisions made by each entity may not be the most efficient and sometimes may even be counterproductive to overall operations.

NASA's Solution

The ***Spot and Runway Departure Advisor, or SARDA***, is NASA's contribution to improving the efficiency of airport surface

Gate Pushback Schedule

Data Exchange

Optimal Runway Schedule

Spot Release Schedule
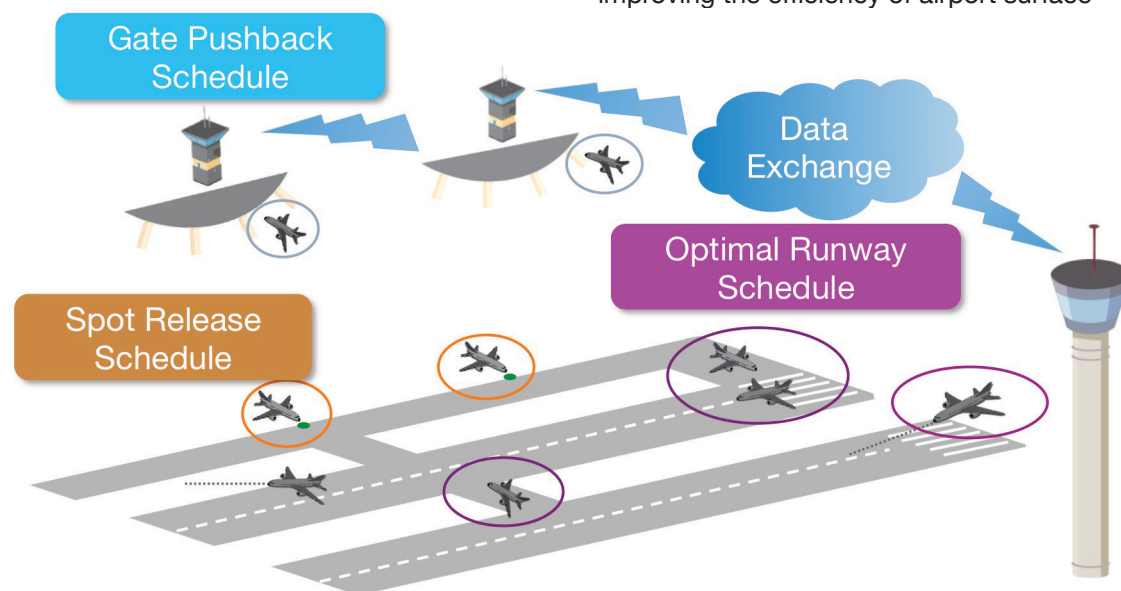
SARDA creates metering advisories for runway usage, spot release into taxiways, and gate pushbacks.

A controller uses the SARDA Ramp Traffic Console (closeup at right) during a simulation of CLT operations.

The SARDA Ramp Traffic Console shows SARDA advisories for departures at gates.

operations. It is the centerpiece of a partnership among airlines, airports, and air traffic controllers to improve operations at the nation's busiest airports.

SARDA uses time-based metering of aircraft to reduce the congestion on the airport surface and both assumes and facilitates a collaboration amongst the various airport surface stakeholders for obtaining better situational awareness of flight operations information. Then, for each aircraft, SARDA provides metering advisories at three main locations: gate, spot, and runway. By controlling the release of aircraft from the gates and the spots, SARDA effectively shifts the delays from the taxiways and runways to the gates. By incurring delays at the gates, with aircraft engines off, fuel and emissions are reduced. Metering of aircraft at the gates also reduces the number of aircraft on the movement area at any time, increasing predictability.

The main algorithm for SARDA operates in two-stages to generate metering advisories. The first stage provides an optimal sequence and times for runway usage (takeoff times for departures and runway crossing times for arrivals). The generated runway schedule complies with various constraints, such as wake vortex separation and Traffic Management Initiatives. The second stage determines times to release aircraft from gates or spots. Dynamic surface conditions are detected and mitigated by executing the algorithm periodically to generate updated optimized solutions.

The SARDA concept has been evaluated in human-in-the-loop (HITL) simulations at NASA Ames Research Center's Future Flight Central (FFC) facility. The FFC

facility provides a 360-degree, full-scale, computer-generated out-the-window view of an airport. Aircraft traffic was simulated on the surface or in the airspace near the airport and displayed on radar maps. Metering advisories from the optimization algorithm were either shown to ATCT controllers through an Electronic Flight Strip (EFS) display system or to ramp controllers through NASA's Ramp Traffic Console (RTC).

Three sets of HITL simulations have been successfully conducted, modeling SARDA in operation at Dallas/Fort Worth International Airport (DFW) in 2010 and 2012, and at Charlotte/Douglas International Airport (CLT) in 2014. In the 2012 simulation of surface operations on the east side of DFW, researchers observed SARDA could achieve reductions of up to 60% in taxi delays and estimated 33% in fuel and emissions. In the CLT simulations, SARDA advisories were found to reduce the departure taxi delay by one minute per flight and the fuel consumption of departing flights by 10-12%. Wait times in the departure runway queue were also found to be reduced, which suggests SARDA improved takeoff time conformance and lowered tower controller workload.

Looking ahead, plans are underway to conduct a joint field test with American Airlines in 2016. Prototype SARDA ramp decision support automation will be tested with operations at CLT.

For more information about the Spot and Runway Departure Advisor (SARDA), please visit **www.aviationsystems.arc.nasa.gov.**