

Overview - Spot and Runway Departure Advisor (SARDA)

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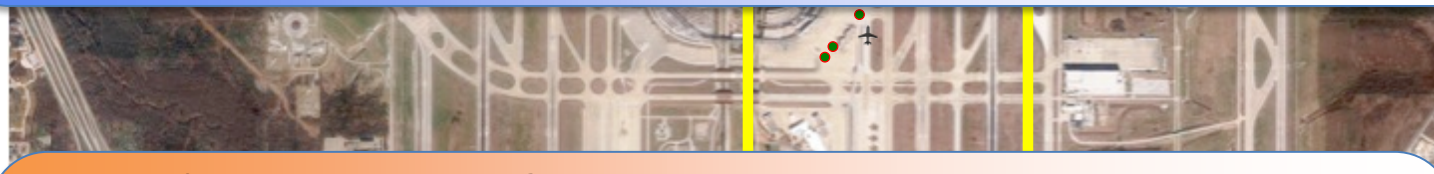
August 14, 2014

Topography of Airport and Surface Management



Consequences:

- Excessive taxi delay
- Excessive fuel consumption and emissions
- Missed opportunities in merging departures into overhead traffic flow



Today's Airport Surface Operations:

- Uncertainties (e.g., flight readiness)
- Lack of common situational awareness and coordination
- Lack of predictability
- First-come, first served operations

Intelligent Scheduling is the Key to Efficient Surface Management



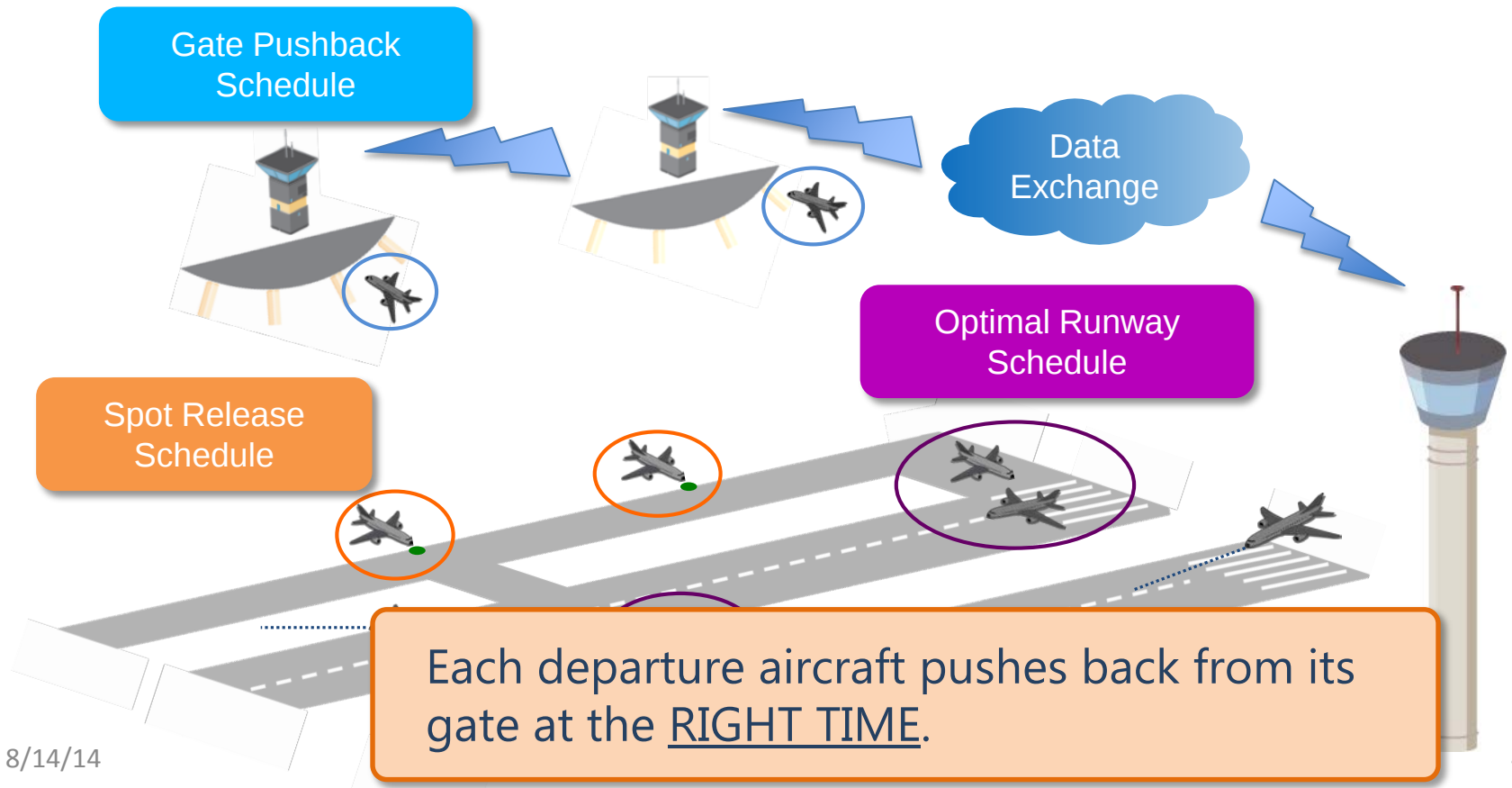
SARDA is the NASA's approach for solving this problem.

- 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 airport tower, en route facility, and airlines
- Adaptable to other airports with different configurations

SARDA Concept

Through collaboration between ATC and airlines, SARDA

- Builds an optimal runway schedule
- Generates spot release sequence and timing
- Determines when to push back departures from gates



Surface Performance Metrics



- Efficiency
 - Taxi time: $\Delta(\text{OFF}, \text{OUT}), \Delta(\text{ON}, \text{IN})$
 - Taxi delay: $\Delta(\text{Actual}, \text{Unimpeded})$
 - Runway queue length
 - Fuel burn
- Predictability
 - Variance in efficiency metrics
 - Accuracy in OFF time prediction
- Throughput
 - Schedule delay: $\Delta(\text{Actual OFF} - \text{Scheduled OFF})$
 - Number of runway operations

SARDA Implementation (1)



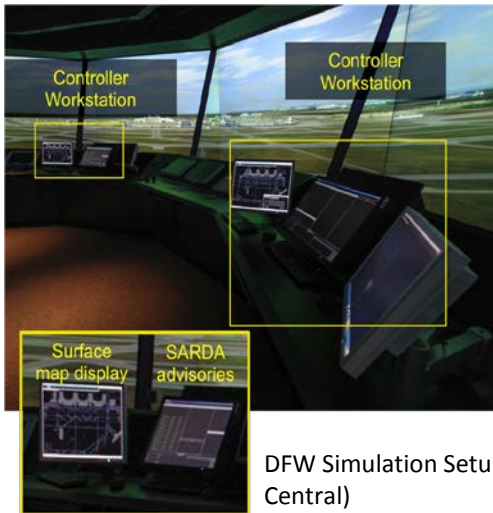
Option1: SARDA as Surface CDM Tool

- Develop a runway schedule and generate spot/gate pushback times through CDM process
- Communicate spot/gate pushback times with airlines
- Refine schedule as traffic situation changes dynamically and provide tactical advisories to ATCT controllers

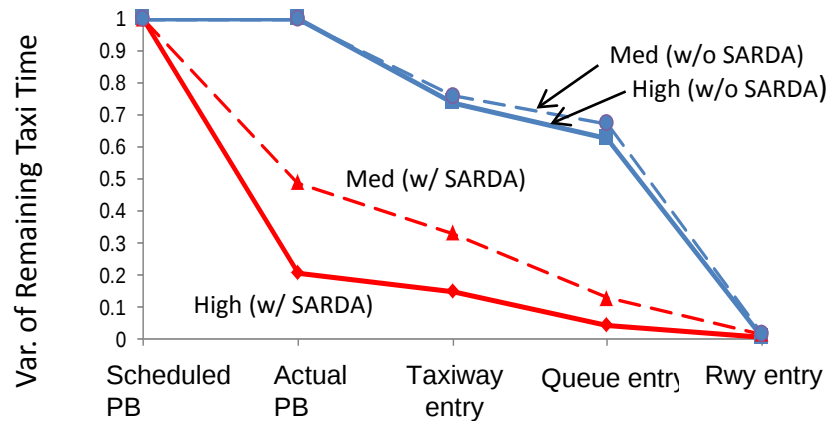
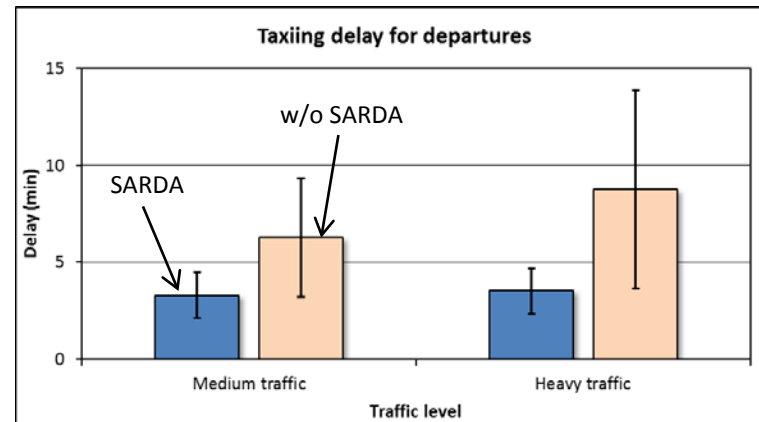
- Ideally for hub airports with multiple carriers
- Data exchange is required (e.g., pushback ready times, TMIs, runway configuration)

ATCT Controller Tool

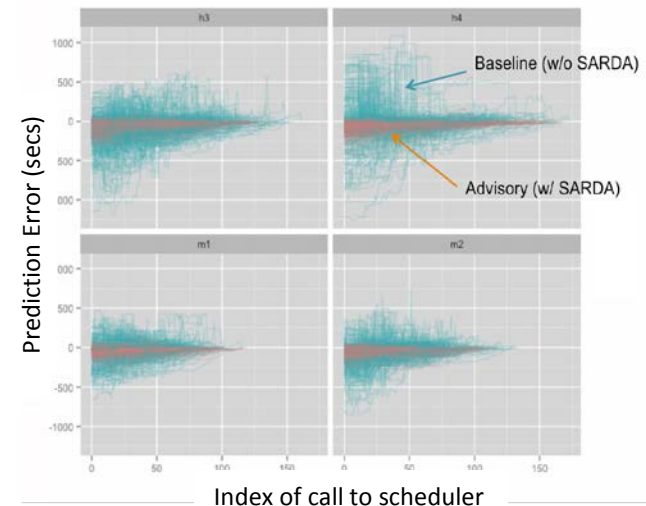
Dallas/Ft. Worth Airport (2012)



DFW Simulation Setup (FutureFlight Central)



Takeoff Time Prediction Error



SARDA Implementation (2)



Option 2: SARDA as Airline Ramp Management Tool

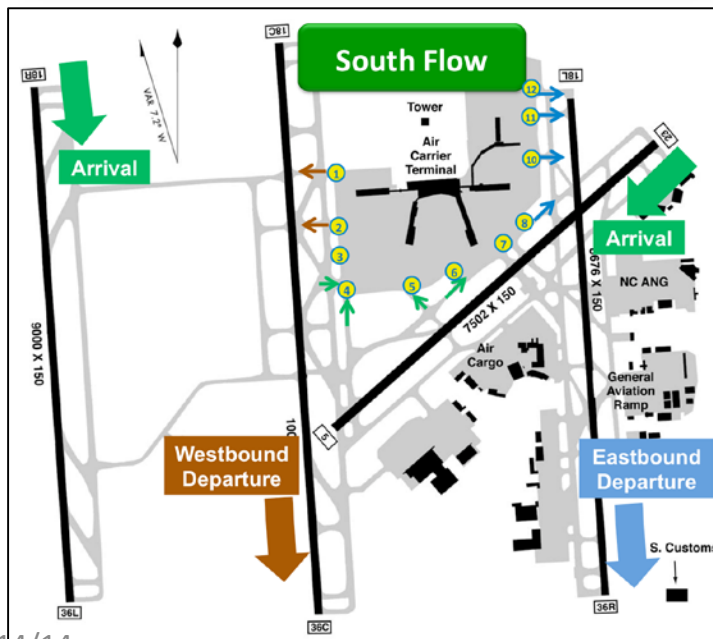
- Develop a runway schedule and generate spot times
- Provide gate pushback advisories to ramp controllers to meet runway/spot schedule

- Ideally for hub airports with a single dominant carrier
- ATCT can have a repeater or employ a SARDA controller advisory tool in parallel
- Data exchange is required

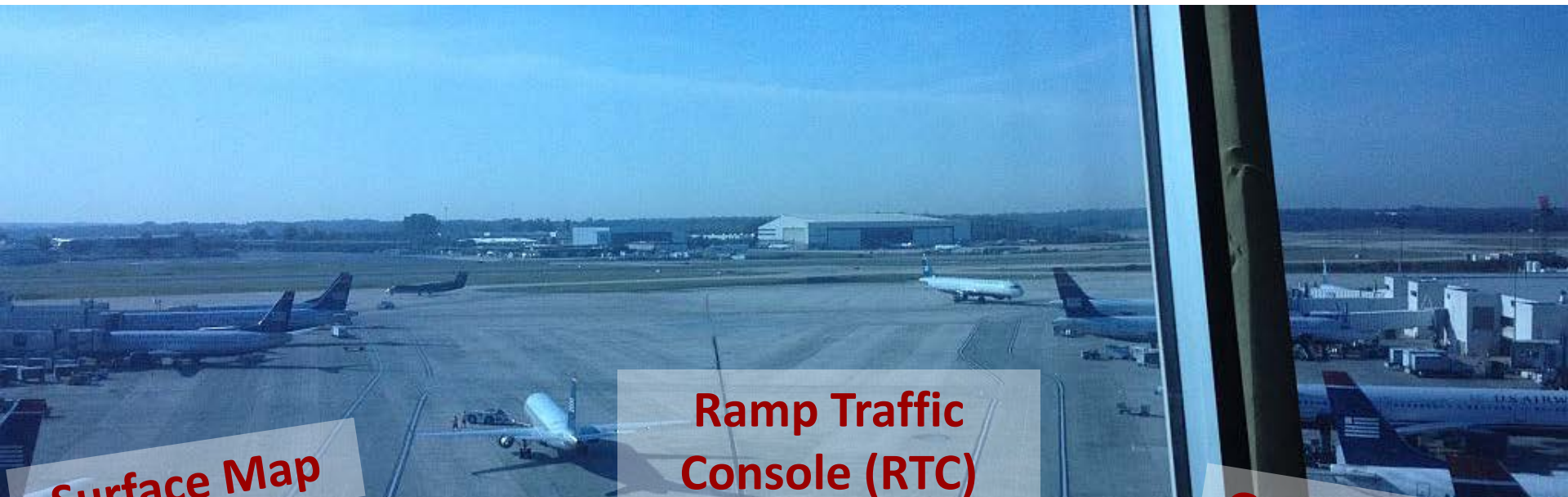
Airline Ramp Management Tool



- NASA-US Airways Collaboration
- Goal: Develop and test a Prototype DST for US Airways Charlotte Airport Ramp Operators
- Conduct a series of HITLs throughout FY14 & 15
- Conduct Field Evaluations in FY15



Ramp Sector Controller Workstation (Illustration Purpose Only)



Surface Map

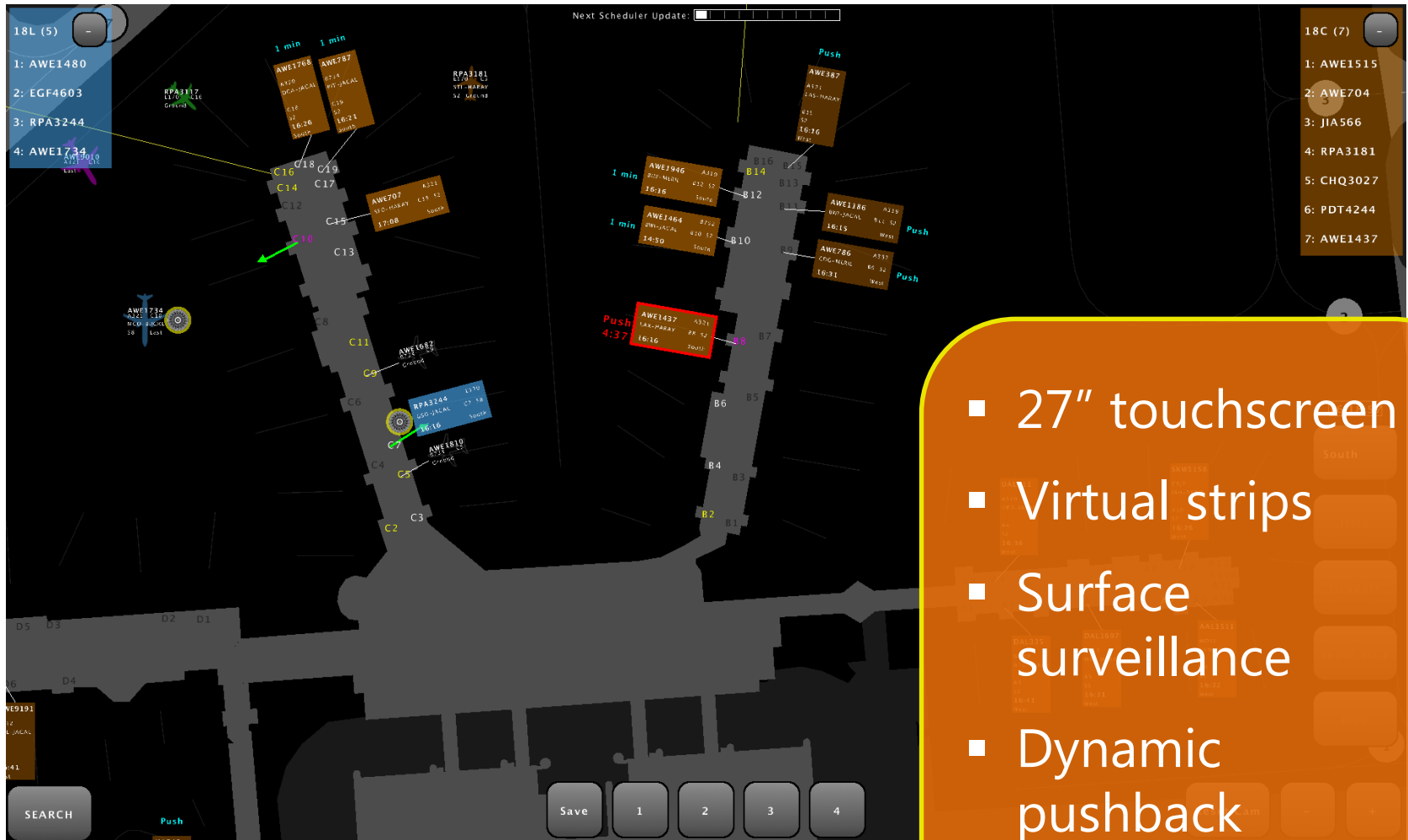
Ramp Traffic
Console (RTC)

Gate Manager



(Touch screen)

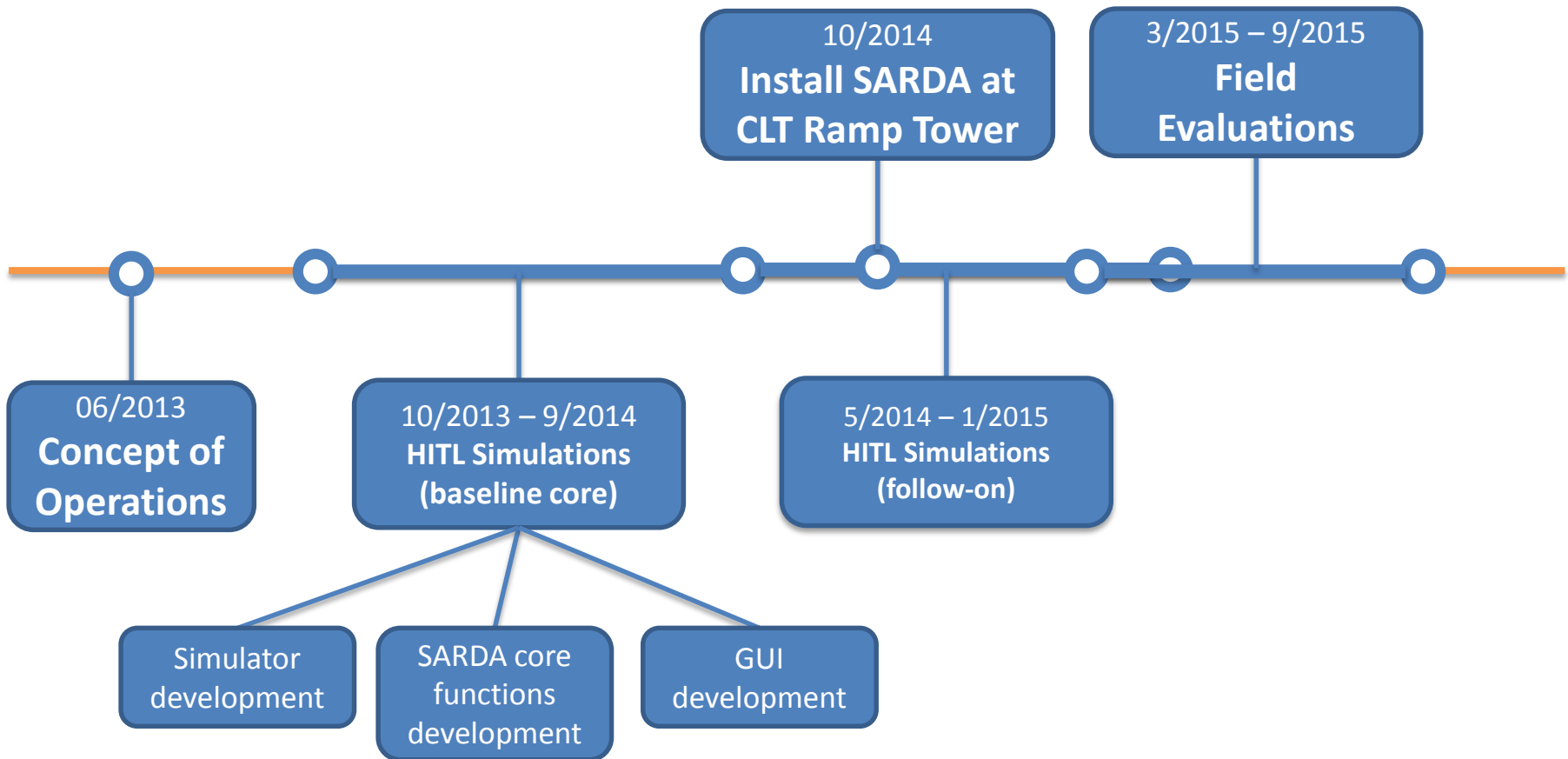
Ramp Traffic Console (RTC)



- 27" touchscreen
- Virtual strips
- Surface surveillance
- Dynamic pushback advisories



CLT SARDA Project Timeline





CLT SARDA HITL Schedule

	No.	Objective	Target	Status
Phase 1	#1	Baseline System	12/13	Completed
	#2	User Interface and Procedures	2/14	Completed
	#3	Scheduler Function	4/14	Completed
	#4	Ramp Operational Constraints	7/14	Completed
	#5	TMIs and Uncertainties	8/14	
Phase 2	#6	Benchmark Test	9/14	
Phase 3	#7	Runway Configuration Change	TBD	
	#8	Off-nominal Situations	TBD	
	#9	ATC Integration	TBD	

On-going/Future Surface Research

- SARDA
 - Conduct field test at CLT
 - Conduct follow-on HITLs
 - Develop simulation for integrated ATC-Airlines surface concept validation
 - Integrate SARDA with flight deck for trajectory-based surface operations
- Expand SOSS modeling capability for IADS research
- Characterize benefits of surface CDM at JFK
- Continue to collaborate with international partners on surface concepts



Partnerships

- Airlines
 - US Airways for SARDA HITLs and field test at CLT
- Airports
 - PANYNJ for surface CDM collaborative research
- FAA
 - Surface Operations Office (AJR-E)
 - Technical Interchange
 - Technology Dev and Prototyping Div (ANG-C5)
 - IADS RTT
 - ASDE-X data feed to ARC (work-in-progress)
 - Operational Concepts, Validation & Requirements (AJV-7)
- International
 - DLR: ConOps, Surface modeling and simulation
 - NLR: Surface Conflict Detection



Questions?

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Backup slides



SARDA - 2014

Waqar Malik
UARC Research Scientist



Motivation

- Inefficiencies in current operations:
 - Aircraft are delayed in departure queues
 - Excess taxi-out times, fuel consumption and emissions
- Departure metering: limiting aircraft queues near runway and taxiways by modulating aircraft pushback



SARDA Concept

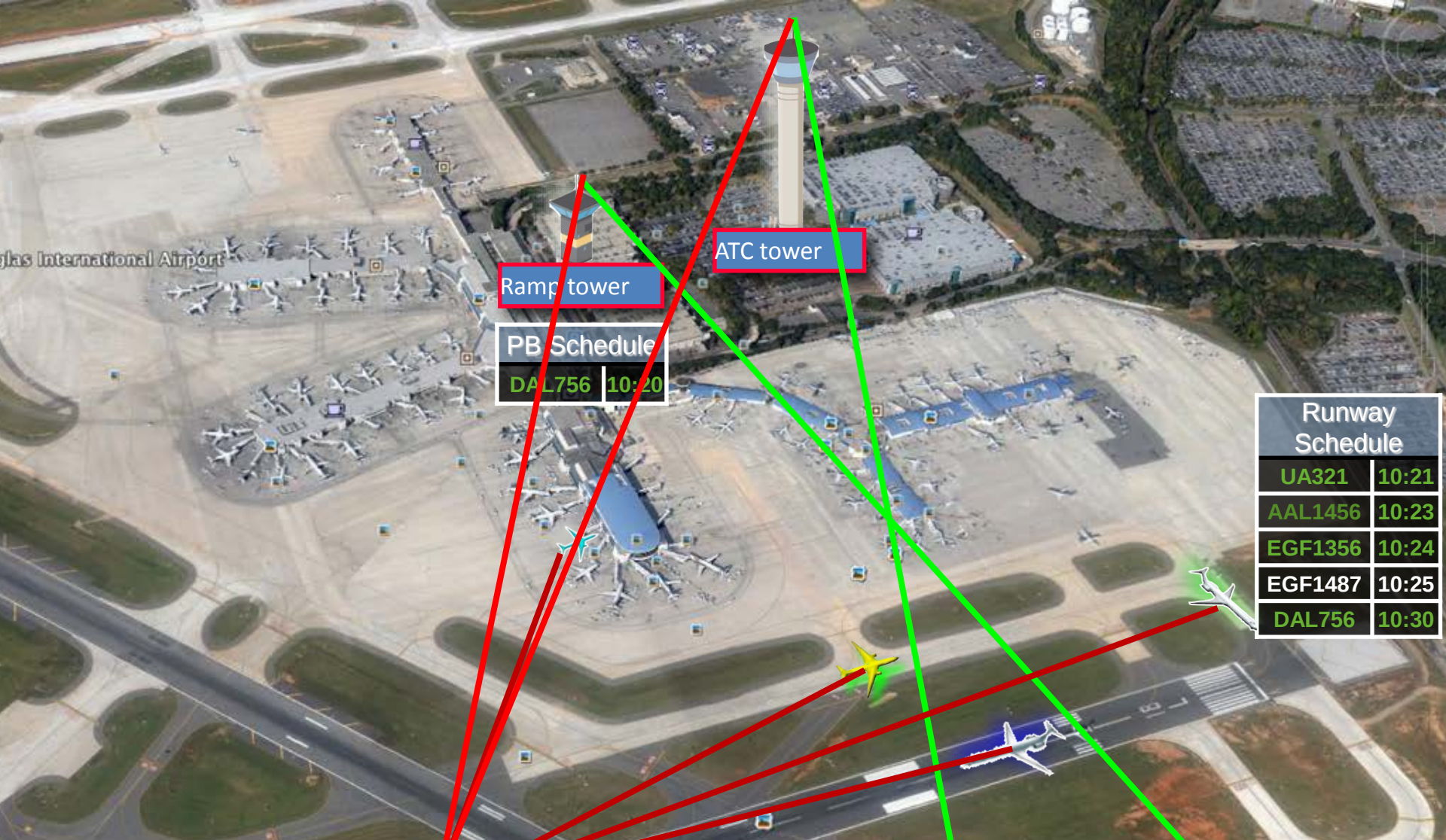
Goal: A collaborative decision support tool for airlines and tower controllers to enhance the efficiency of surface traffic.

- Airline Operator Advisory
 - Provide gate push-back times to airlines
- Ground Controller Advisory
 - Provide spot/ramp release schedule to reduce taxi delay while maintaining runway throughput
- Local Controller Advisory
 - Provide take-off and crossing sequence for efficient and safe runway usage



SARDA History

- SARDA - Spot and Runway Departure Advisory
 - Initial proof of concept (as a tower tool) was developed for DFW airport and tested at the FutureFlights Central (FFC)
 - Reduction in AMA taxiing delay for departures (45% in medium, 60% in heavy), and reduced variation
 - Take-off time was predicted reliably under advisory condition

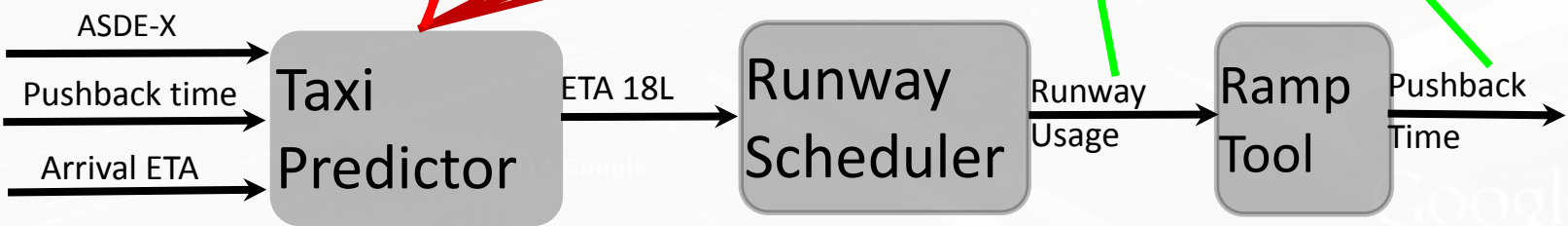


Ramp tower

ATC tower

PB Schedule
DAL756 10:20

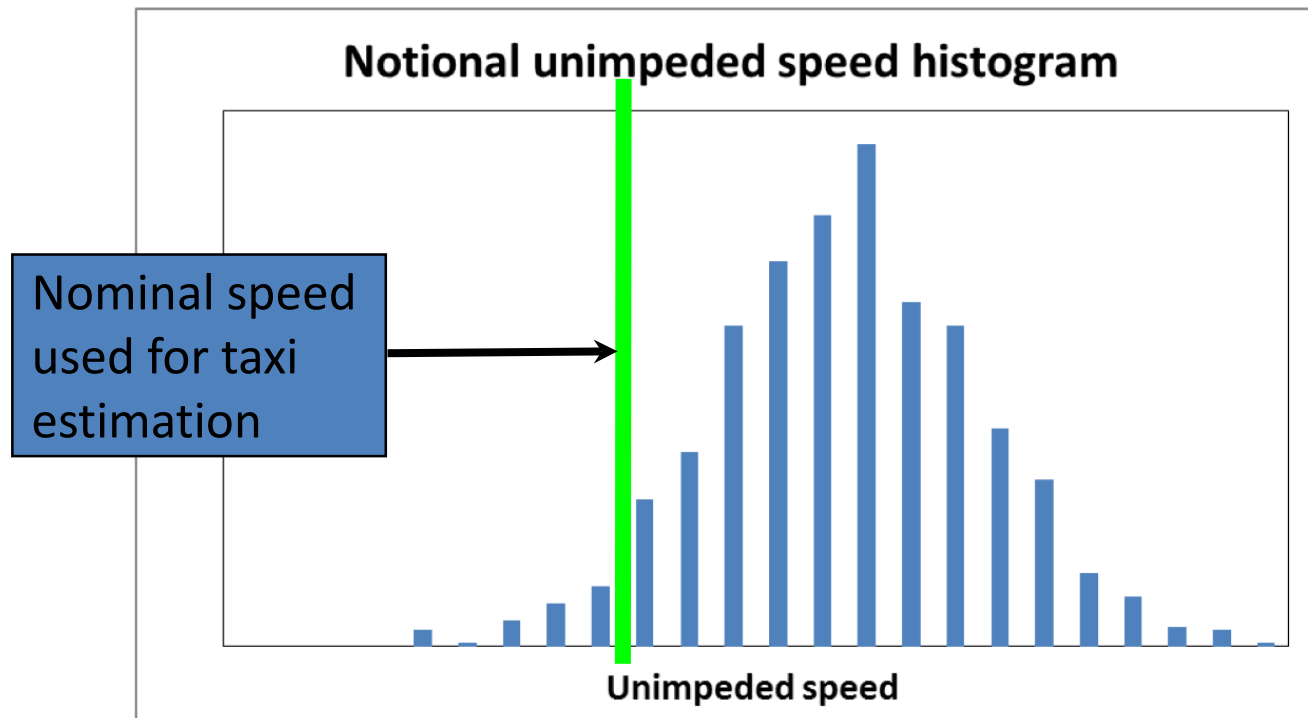
Runway Schedule	
UA321	10:21
AAL1456	10:23
EGF1356	10:24
EGF1487	10:25
DAL756	10:30



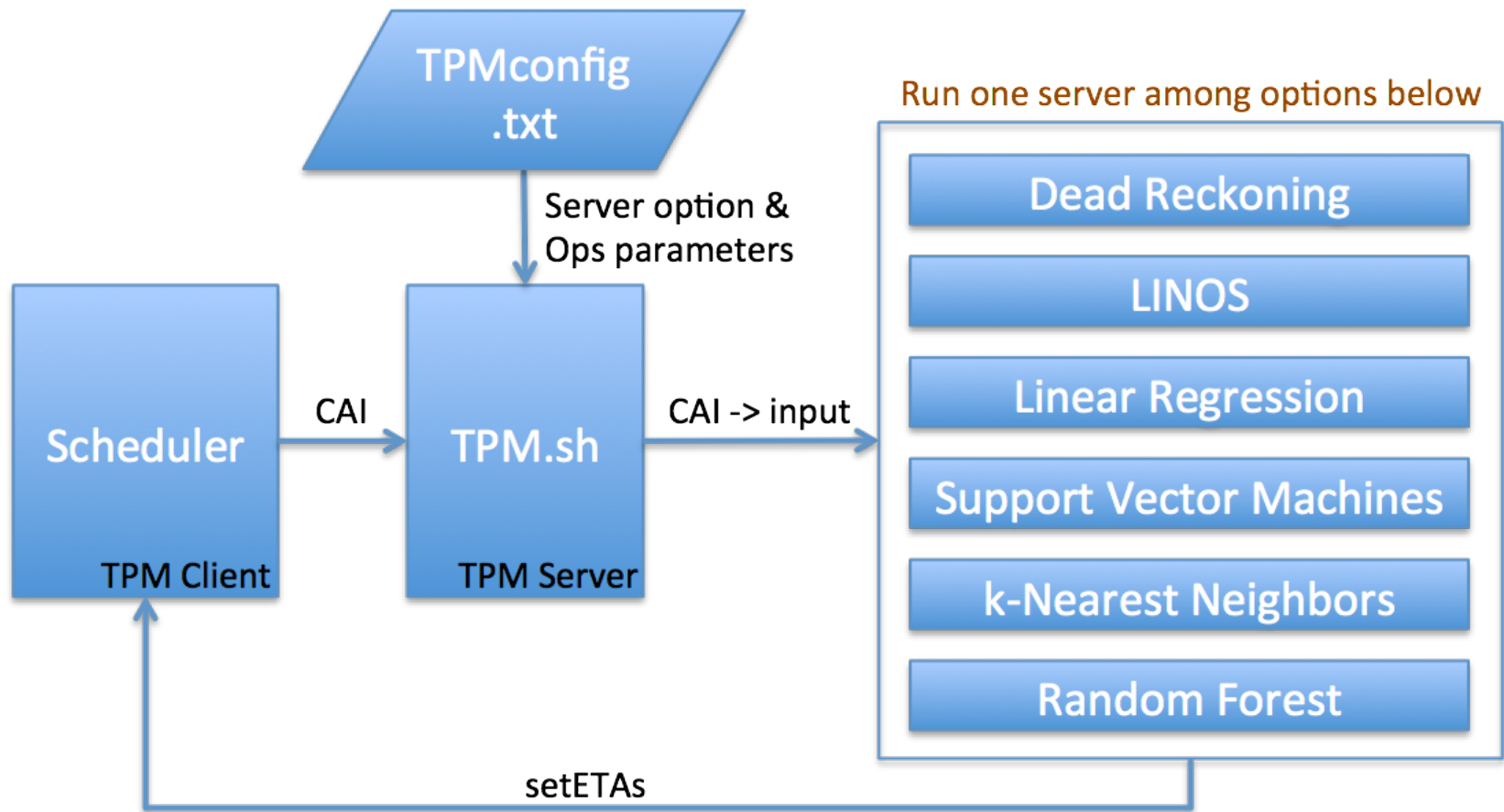


Taxi Predictor

- Simple kinematic model used.
- Analyzed unimpeded aircraft movement at CLT
- A single value from the speed distribution is chosen as the unimpeded speed for all aircraft



Taxi Prediction Module (TPM)





Runway Scheduler

- Estimated runway queue entry times (for departures).
- Estimated runway time (for arrivals).
- Spot, runway and fix/exit for each aircraft.
- Type (weight class) of each aircraft
- Wake vortex separation criteria for take-off/crossing
- Separation criteria for particular aircraft pairs (MIT)
- Individual time-windows of intended take-off times for departing aircraft (EDCT, CFR)



Runway Scheduler

- Mixed Integer Linear Program



Pushback Calculator

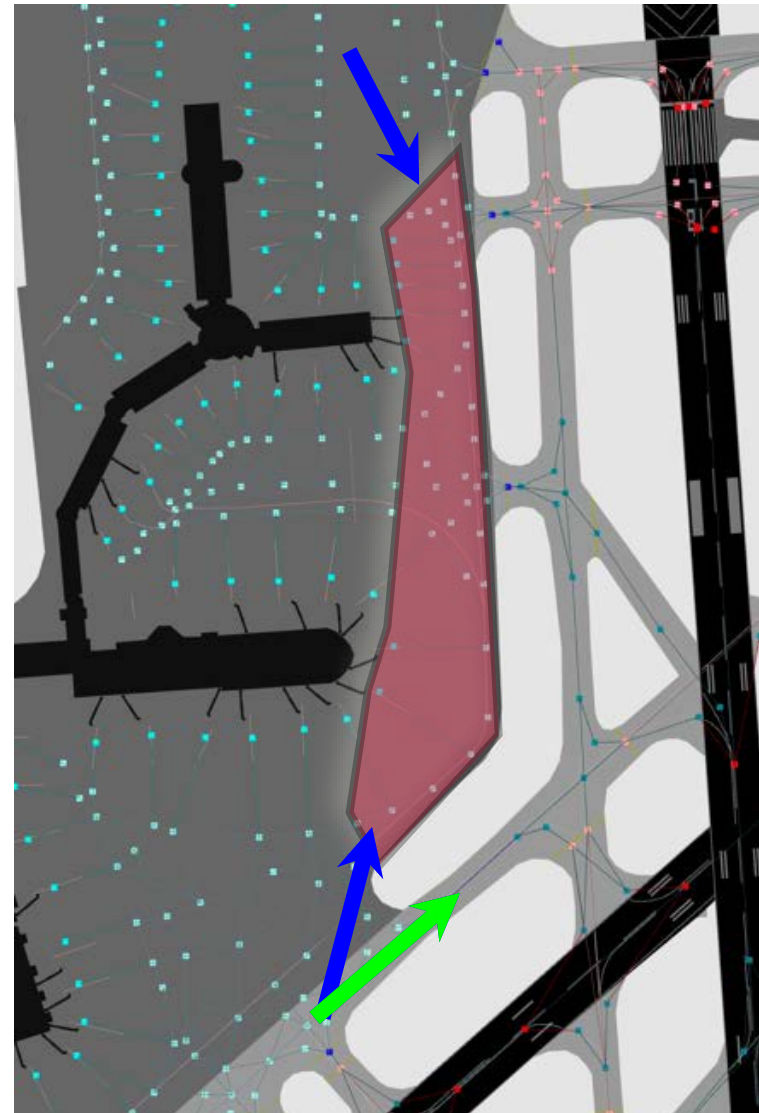
Gate Release Time =

(Calculated Take Off Time) - (Estimated Taxi Time)

Single Lane Advisory

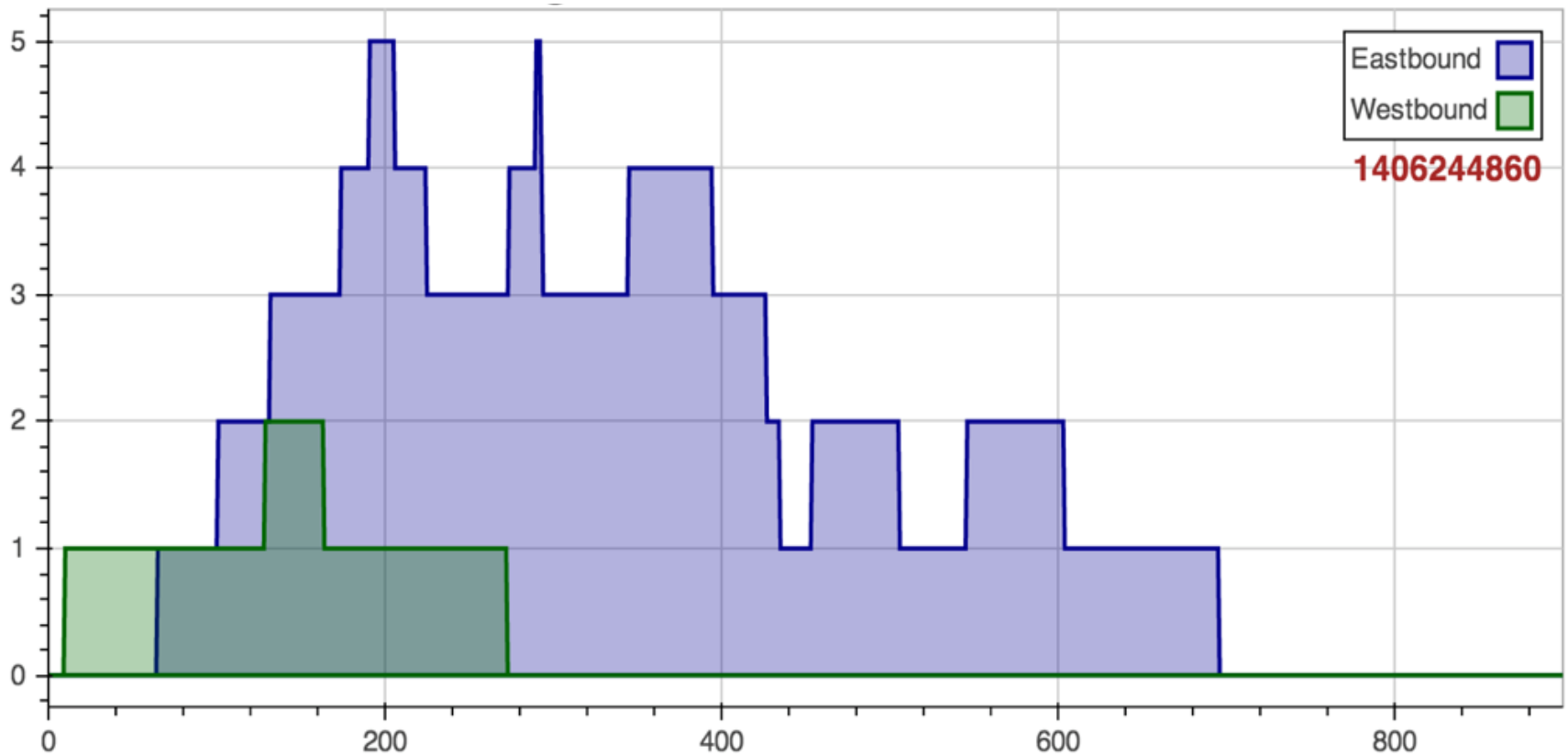


- Provide advisories for single lane use.





Single Lane Advisory

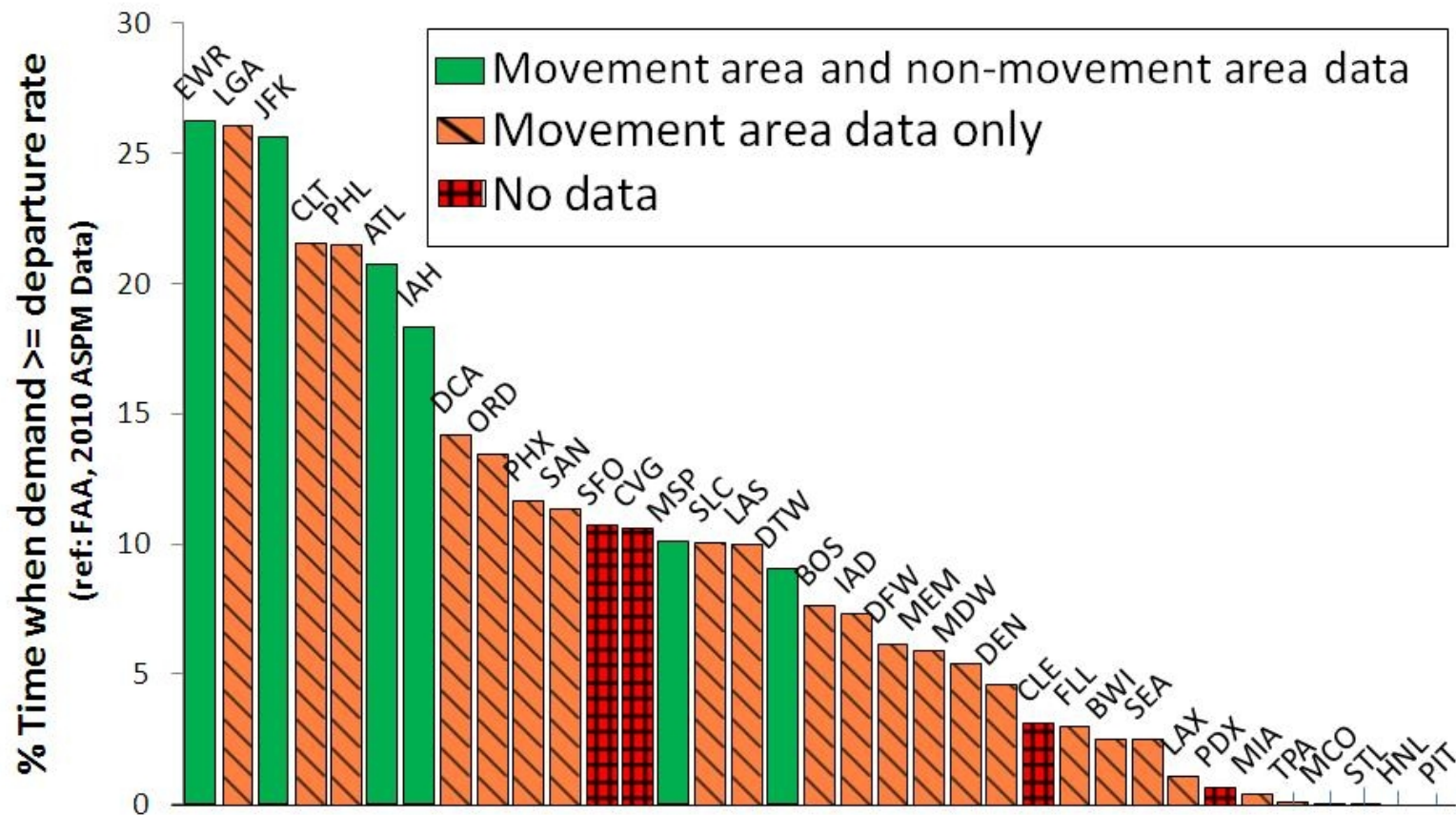


Scheduled Departure Demand vs. Departure Capacity



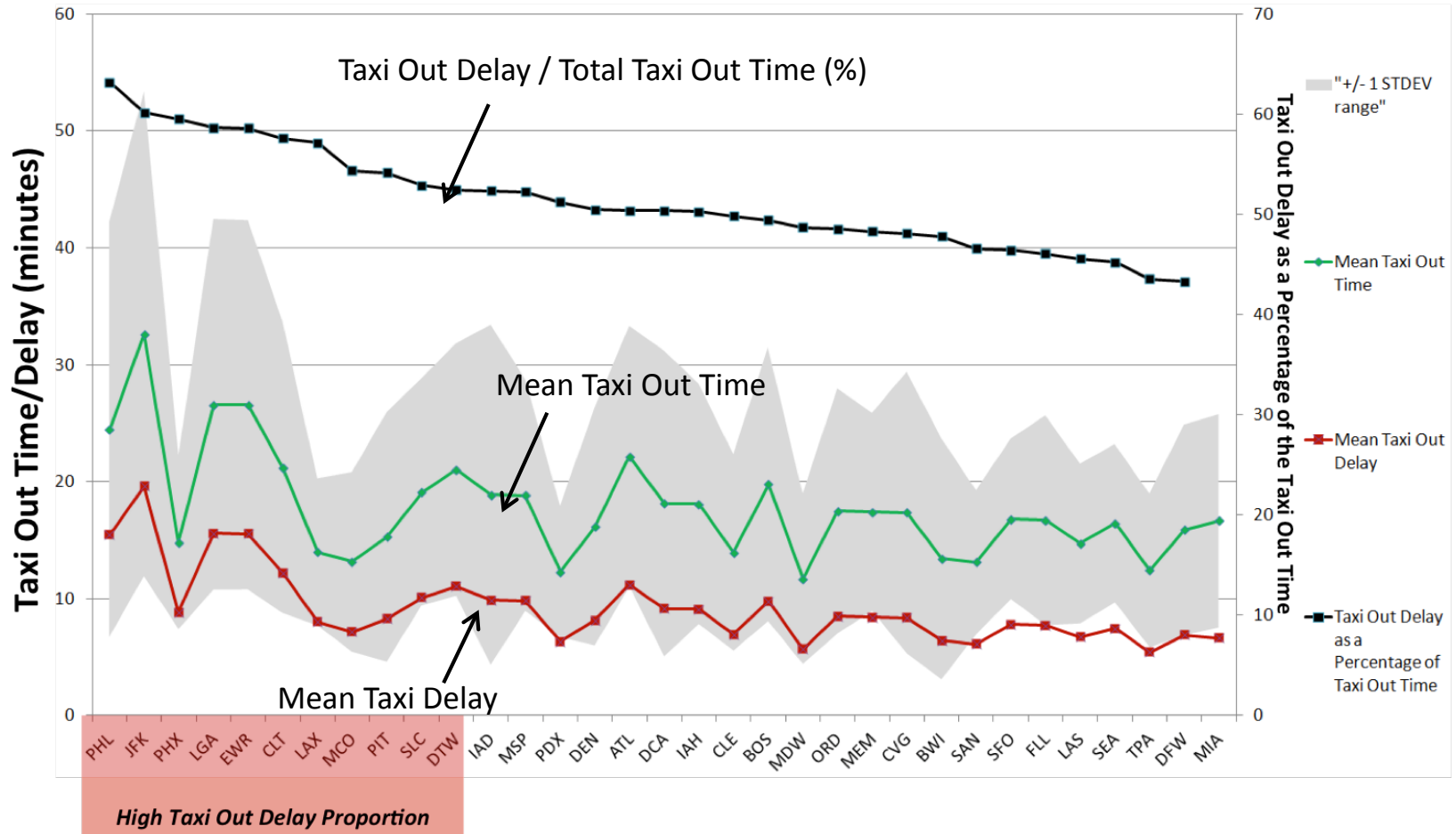
(Source: ASQP Data from year 2010)

35 OEP Airports

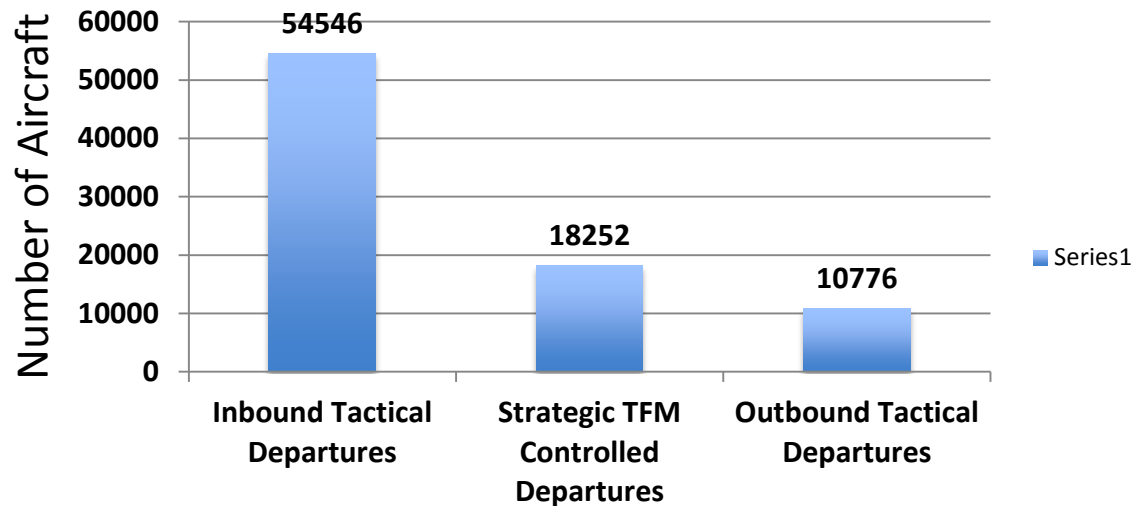


Taxi Out Delay for OEP airports

(Source: ASQP Data from year 2009; all times are in minutes)



Missed Opportunities for Tactical Departure Scheduling



January 2011

System	Hit Scheduled Slot %	Hit First Surveillance Slot %	Estimated Number of Aircraft that missed slot due to departure time uncertainty
Arrival TMA	26.9	39.3	6,792
EDC	39.4	57.1	1911

Source: Capps, A. et al., "Characterization of Tactical Departure Scheduling in the National Airspace System," 11th AIAA ATIO Conference, Virginia Beach, VA, Sept 2011



Monthly Mean Taxi Time (2013)

