Use of Airport Surface Simulations for ATD-2 Benefits Assessment

Presentation at the NASA ATD-2 Industry Workshop

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Outline

- Objectives
- Benefits analysis methodology
- Simulation platform
- Results
- Conclusions and Simulation-related lessons learned

Objectives

- Estimate benefits provided by NASA's ATD-2 system
  - At three major U.S. airports (CLT, DFW, EWR)
  - Via high-fidelity simulations using NASA's SOSS (Surface Operations Simulator and Scheduler) simulation platform
- Extrapolate to nationwide benefits
- Compare ATD-2 costs with benefits on a nationwide scale

Methodology

- Identify ***operational shortfalls*** that ATD-2 can address and associated ATD-2 ***benefit mechanisms*** and ***benefit metrics***
- Develop a ***combined airspace-surface simulation platform*** that can simulate key operational shortfalls and benefit mechanisms
- Conduct ***high-fidelity surface-airspace simulations*** for simulating current-day and future ATD-2 operations at ***three airport sites*** and ***carefully selected simulation days***
- Extrapolate results to FAA Core 30 airports using ***medium-fidelity queuing simulation models*** and FAA ***TFDM benefits analysis results***
- Extrapolate to ***annualized*** benefits
- Follow ***FAA-recommended processes*** for cost analysis
- Compute ***advantages to the FAA's TFDM program***

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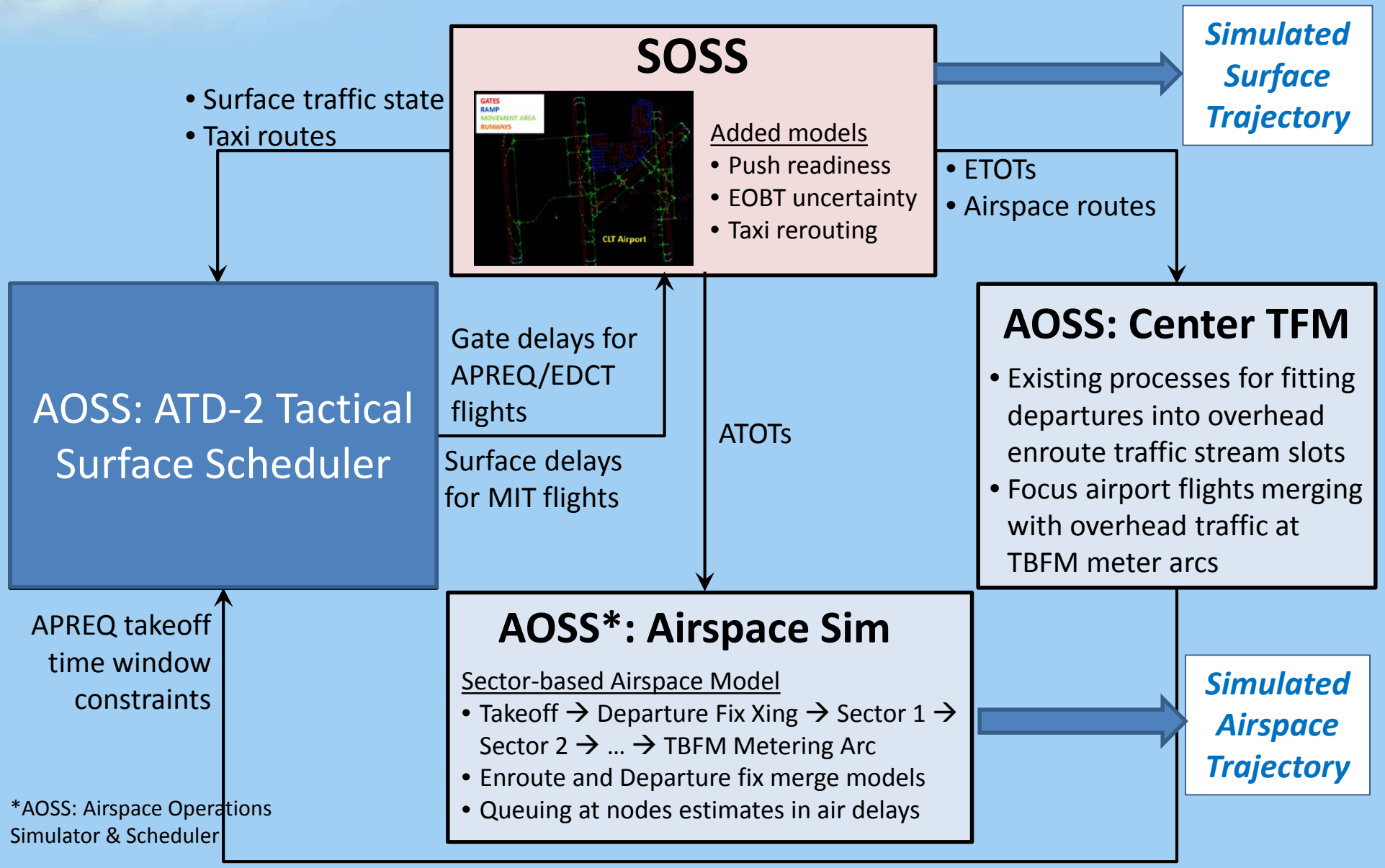
COMBINED SURFACE-AIRSPACE SIMULATION PLATFORM

Combined Airspace-Surface Simulation Platform Architecture



*AOSS: Airspace Operations Simulator & Scheduler

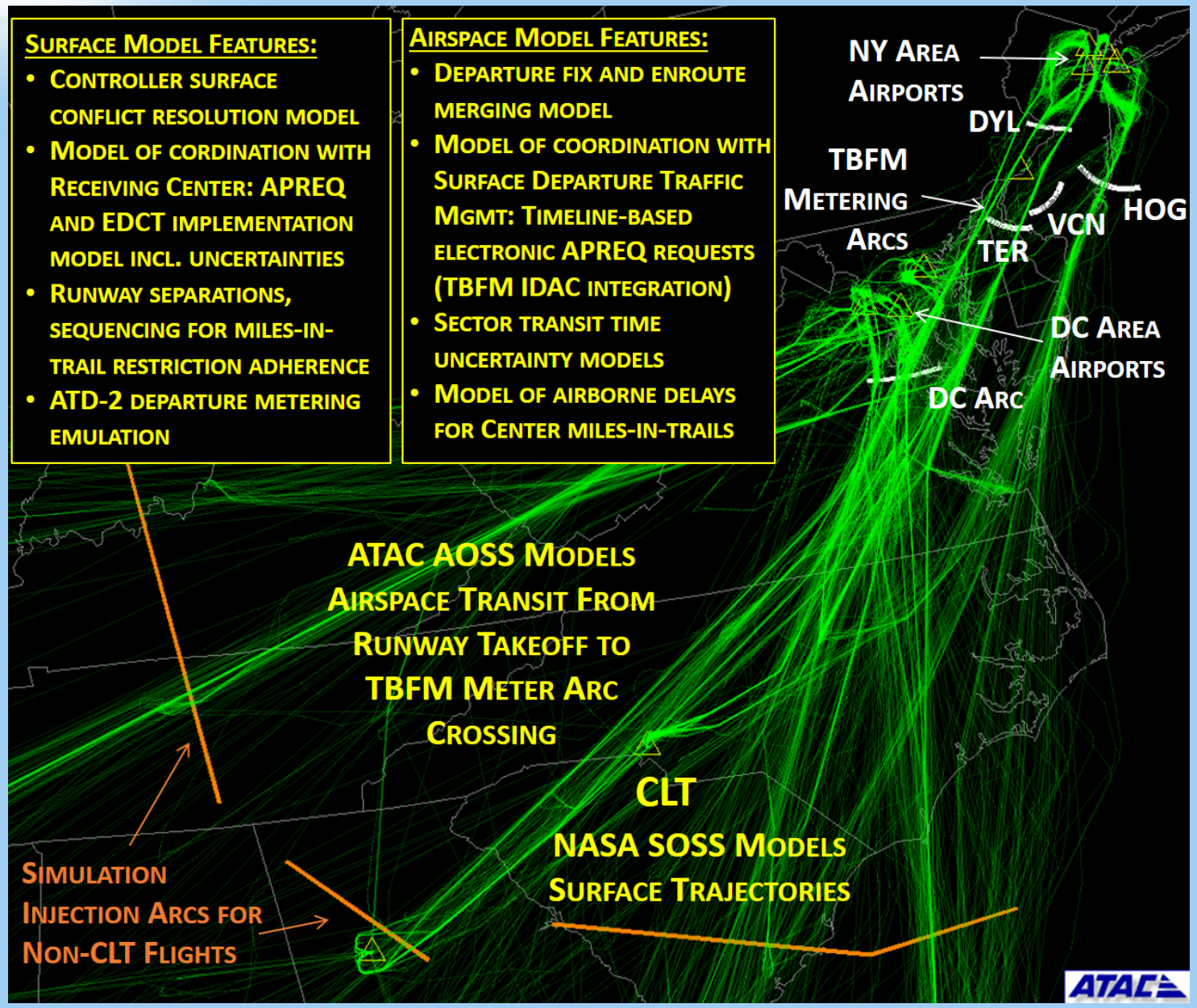
CLT Combined Surface-Airspace Model

Surface Model Features:

- Controller surface conflict resolution model
- Model of cordination with Receiving Center: APREQ and EDCT implementation model incl. uncertainties
- Runway separations, sequencing for miles-in-trail restriction adherence
- ATD-2 departure metering emulation

Airspace Model Features:

- Departure fix and enroute merging model
- Model of coordination with Surface Departure Traffic Mgmt: Timeline-based electronic APREQ requests (TBFM IDAC integration)
- Sector transit time uncertainty models
- Model of airborne delays for Center miles-in-trails



Benefit Mechanisms Modeled

- Data Exchange
  - EOBTs provided to the ATD-2 Tactical Scheduler
  - Leads to accurate OFF time estimates
  - ATD-2 Scheduler communicates gate release times to the airline
- Tactical Surface Scheduling
  - High-fidelity emulation of Tactical Surface Scheduling algorithm enables sequencing and gate holds
- Integrated Airspace Scheduling
  - APREQ release times negotiated based on accurate OFF time estimates with receiving Center
  - APREQ delays absorbed at the gate

Experiment Design: Simulation Days Selection

Condition	TMI/ APREQ Indices	Weather		Demand	Recom. Date	# Days	% Occur.	Total Daily Precip (in)
		CONUS	Apt					
1	2	2	2	2	6/15/2016	16	14.3%	2.74
2	1	2	2	2	5/17/2016	15	13.4%	0.87
3	2	2	1	2	6/1/2016	13	11.6%	0.1
4	1	2	1	2	8/15/2016	8	7.1%	0.27
5	1	1	1	2	5/6/2016	6	5.4%	0.28
6	0	1	1	2	8/13/2016	4	3.6%	0
7	2	1	1	2	5/31/2016	4	3.6%	0.59
8	1	1	2	2	4/12/2016	4	3.6%	0.39
9	1	1	0	0	7/23/2016	3	2.7%	0
10	0	0	0	2	6/4/2016	3	2.7%	0
11	1	0	0	2	6/5/2016	3	2.7%	0.08
12	2	2	0	2	6/21/2016	3	2.7%	0
13	0	2	2	2	6/17/2016	3	2.7%	0
14	1	0	0	0	7/4/2016	2	1.8%	0
15	2	0	0	0	5/1/2016	2	1.8%	1.2

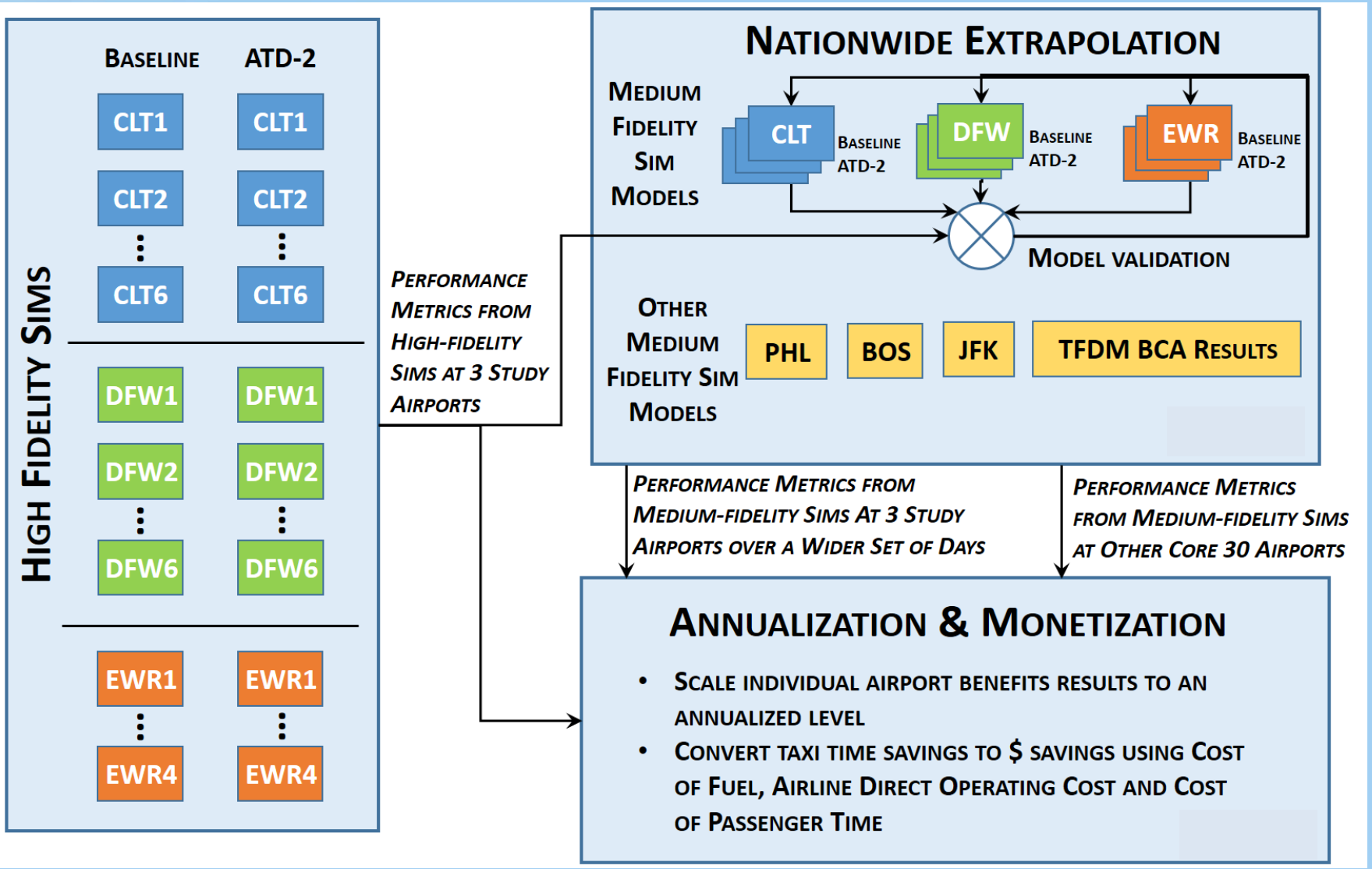
Σ % Occur. = 80%

Tercile grouping rules

Condition	Good (0)	Fair (1)	Poor (2)
APREQ/MIT indices	Both < 50%	One > 50%	Both > 50%
CONUS WITI	≤ 33⅓ %	> 33⅓ % and ≤ 66 ⅔%	> 66 ⅔%
Local WITI	≤ 33⅓ %	> 33⅓ % and ≤ 66 ⅔%	> 66 ⅔%
Departure index	≤ 33⅓ %	> 33⅓ % and ≤ 66 ⅔%	> 66 ⅔%

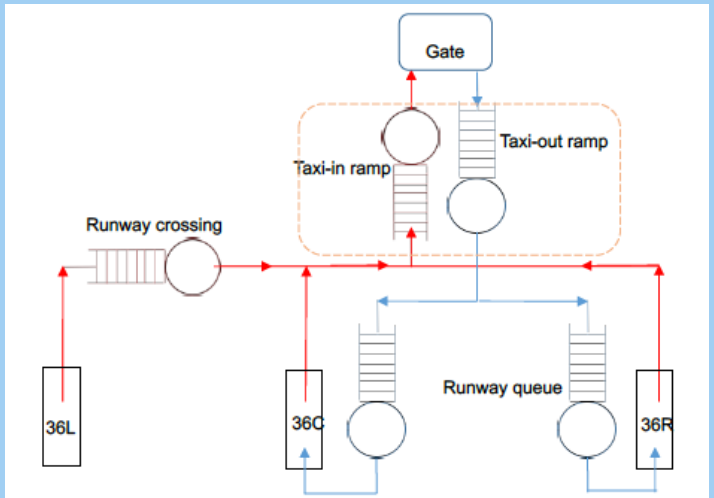
Encompasses 80% of operational conditions for FY2015

Benefits Analysis & Extrapolation

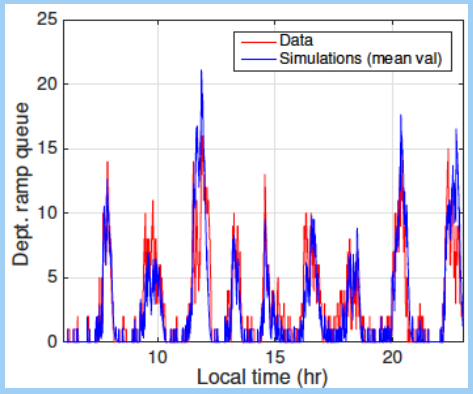


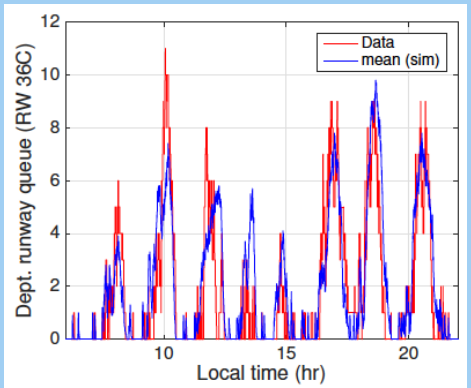
Mesoscopic Models of CLT

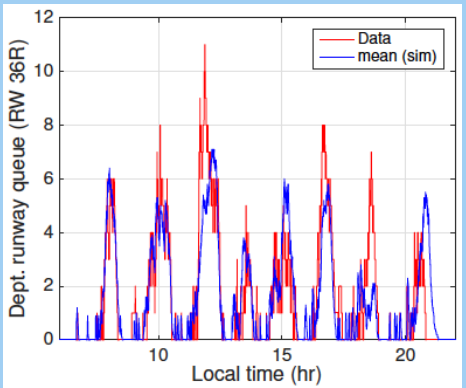
- Both baseline and ATD-2 metering models

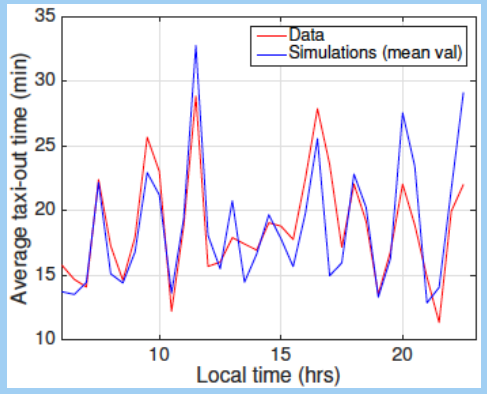


Departures	Actual	Error
(14,122 flights)	Avg. (min)	
Taxi-out time	20.2	0.7
Gate to spot	9.7	-0.3
Spot to runway	10.5	1.0
Arrivals (16,383 flts)	10.2	0.5



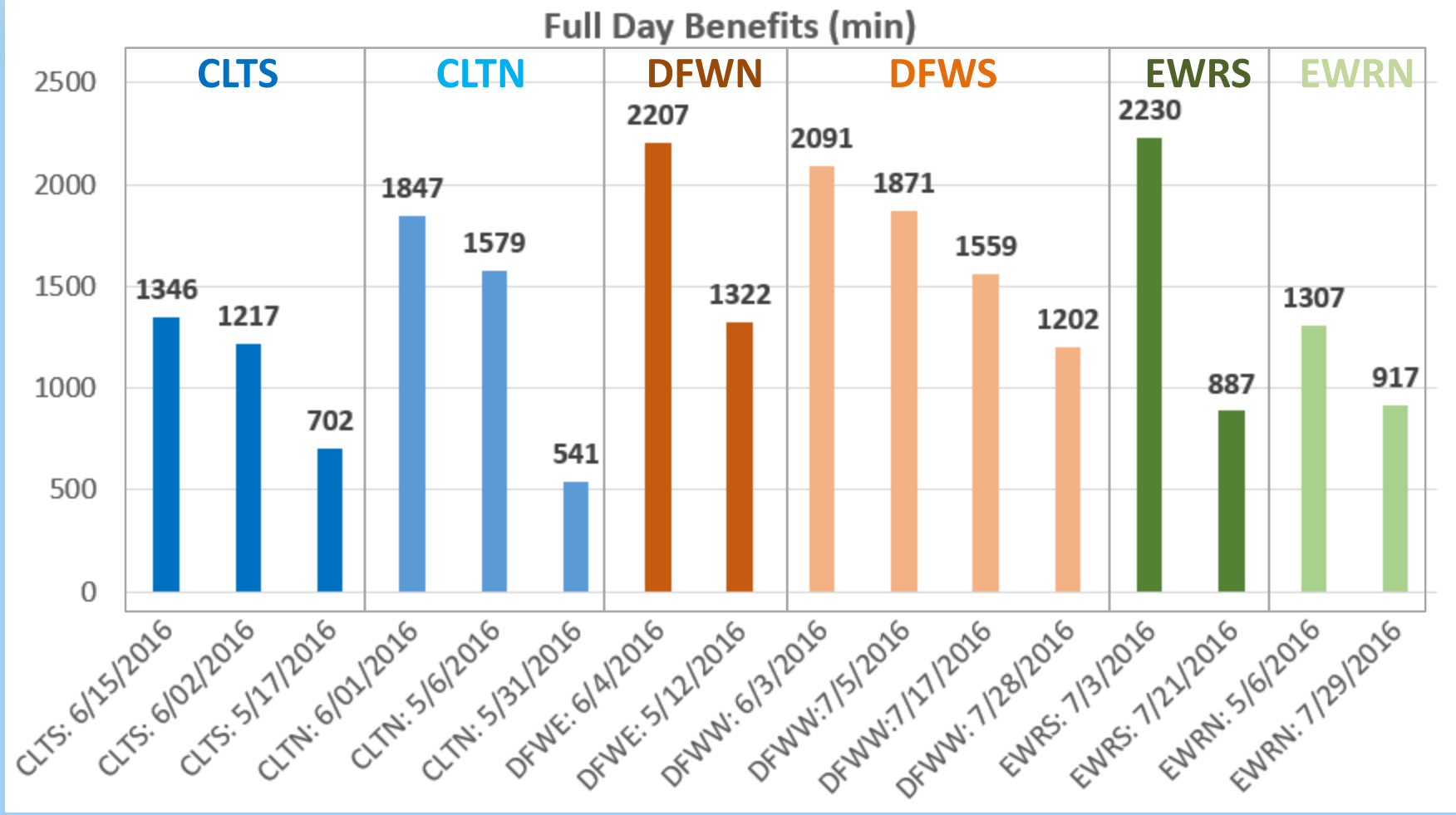






RESULTS

Summary of Taxi-Out Time Saving Benefits



	CLT	DFW	EWR
AVERAGE PER DEPARTURE TAXI-OUT TIME SAVING (MIN) =	1.72	1.89	2.34

Benefits Calculation

- Two primary benefits
  - Shifting delays from taxiways to the gates
    - Fuel Savings for reduced taxi time
  - Earlier off time
    - Airline Direct Operating Costs (ADOC)
    - Passenger Value of Time (PVT)

Annual Benefits =

Σ[(Benefits on individual simulation day) X Number of similar days in the year]

Cost Analysis

- Examine major cost drivers within the TFDM program
- Apply risk reduction to parts of the TFDM program
  - Assume a small decrease in the point estimate due to NASA ATD-2 work
- Risk parameter adjustments
  - Mode decreased by 2.5%

Economic Analysis

- Apply changes to cost & benefits to the base TFDM Benefit-to-Cost ratio (B/C)

- Methodology
  - $(B/C)_{TFDM}$ =1.03, from earlier study
  - B_{ATD2}= 1.77*B_{TFDM}; C_{ATD2} = 0.965*C_{TFDM}
  - $(B/C)_{ATD2}$ = 1.77/0.965*1.03 = 1.89

CONCLUSIONS AND LESSONS LEARNED

Conclusions

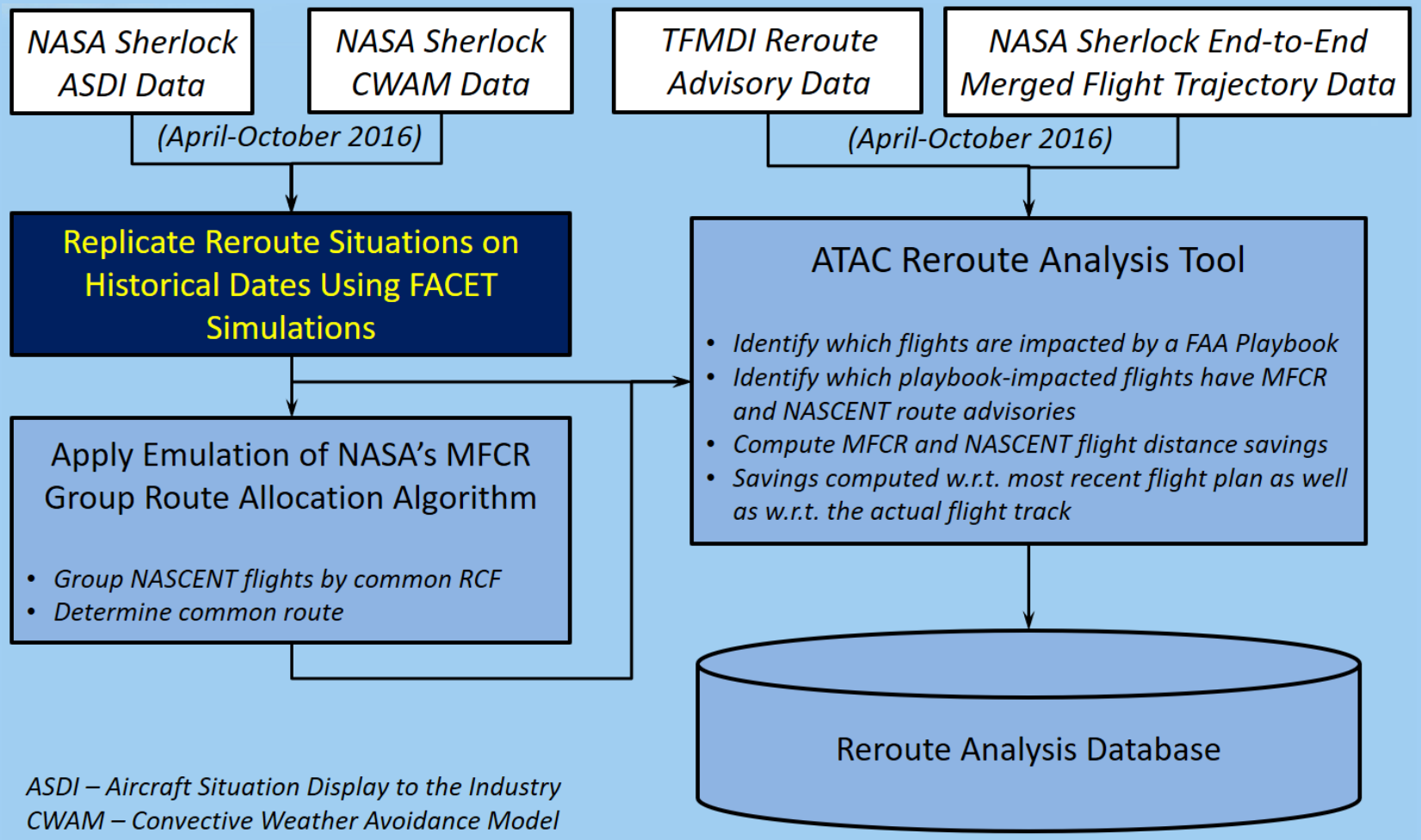
- ATD-2 offers significant taxi-out time savings benefits at congested airports in the NAS, without having negative impact on taxi-in times, OFF time performance and airport throughput
- Annual total of 3.5 million minutes of reduced taxi-time at CLT, EWR, and DFW
- $2.6 Billion in monetary benefits nationwide due to significant reduction in taxi times as well as in surface delay
- Incorporation of ATD-2 into the FAA's TFDM system improves the B/C ratio of the TFDM program from 1.03 to 1.89

Use of Simulations for Benefits Assessment: Lessons Learned

- Model validation is complex
- Careful selection of simulation timeframes is important
- High-fidelity of simulations can limit the number of scenarios we can simulate

Other Examples of Simulation Use

- ATAC NRA – Benefits Assessment of Multi Flight Common Routes (MFCR)
  - Applied FACET simulations to emulate rerouting situations on real historical days

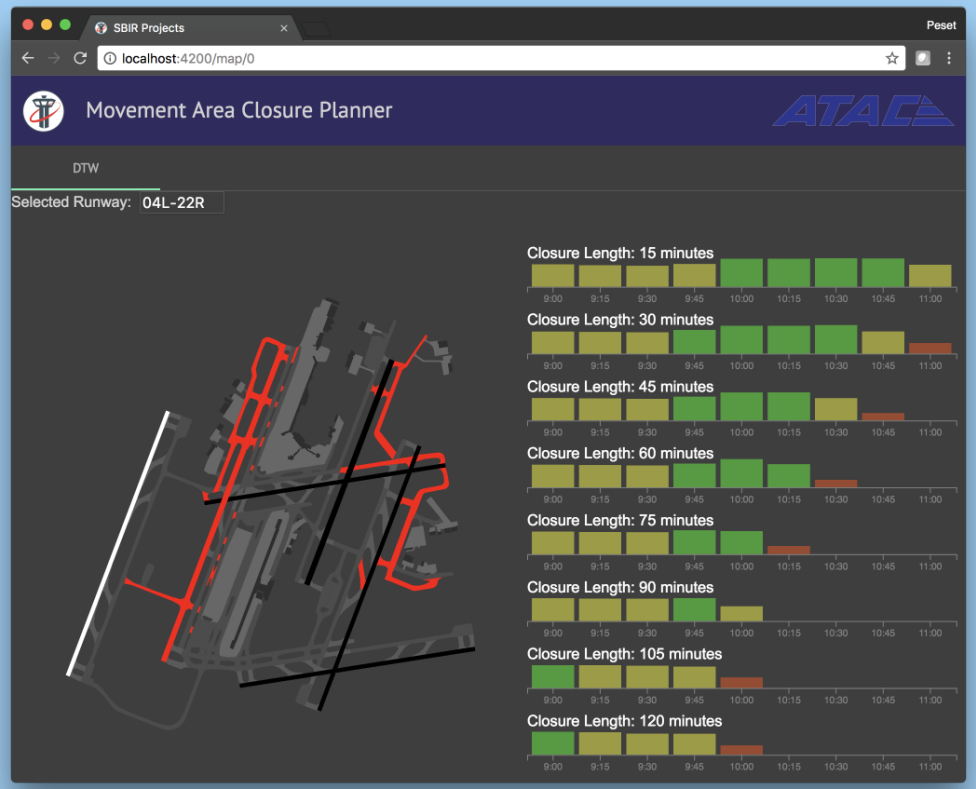


ASDI – Aircraft Situation Display to the Industry
CWAM – Convective Weather Avoidance Model
TFMDI – TFM Data to the Industry

FACET = Future Airspace Concepts Evaluation Tool

Other Examples of Simulation Use

- ATAC Phase II SBIR – NAS Element Closure Planner
  - What-if analysis simulation for recommending optimum closure times and durations



QUESTIONS

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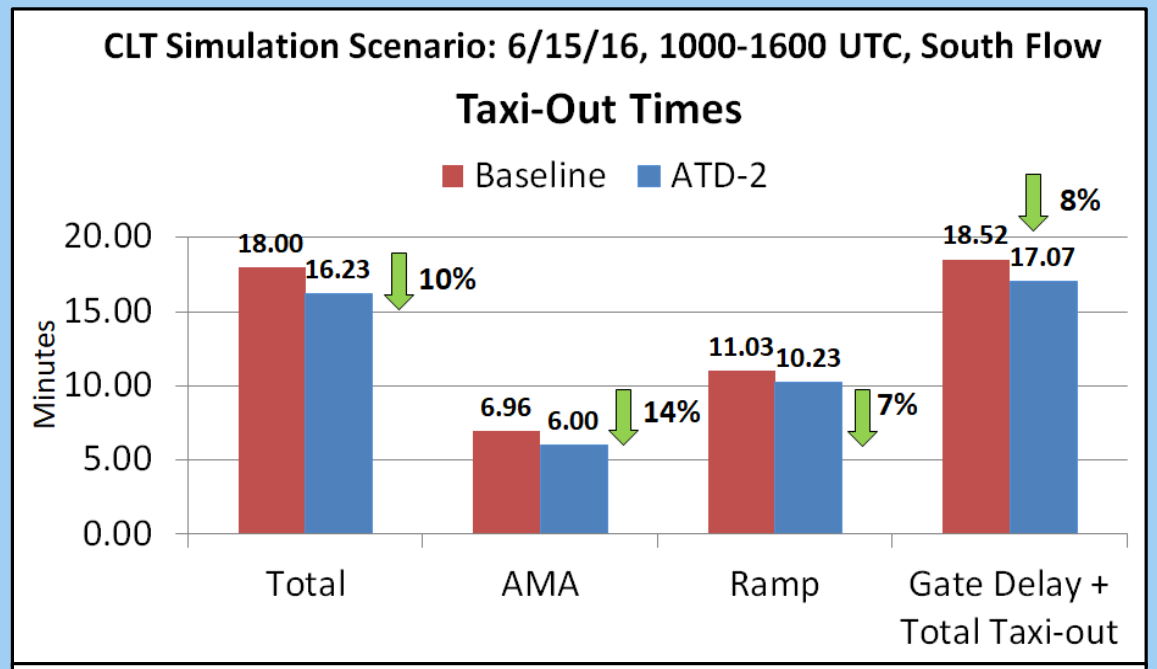
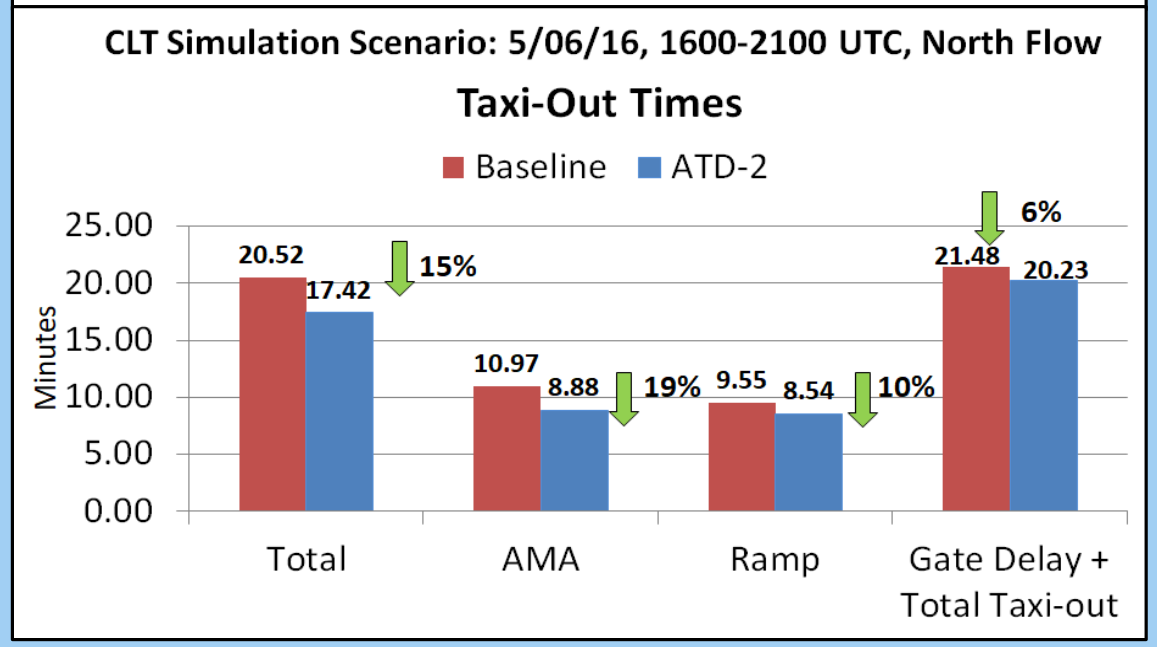
BACKUP SLIDES

Efficiency: Taxi-Out Time Savings

Sim #1: 06/15/2016
South Flow
1000-1600 UTC

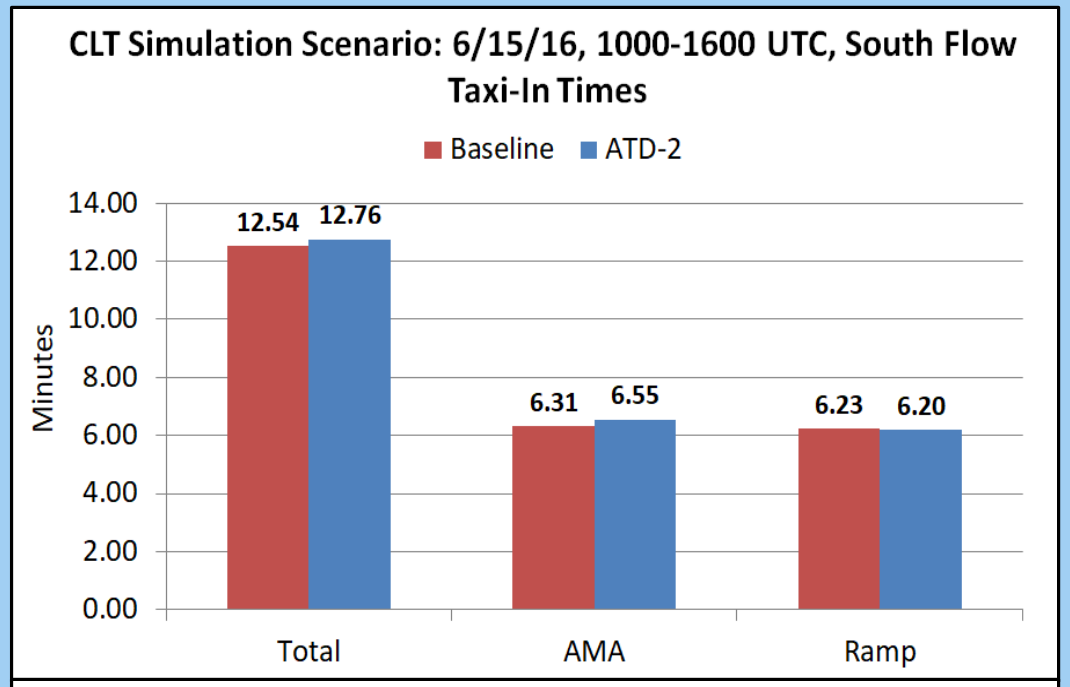


Sim #2: 05/06/2016
North Flow
1600-2100 UTC

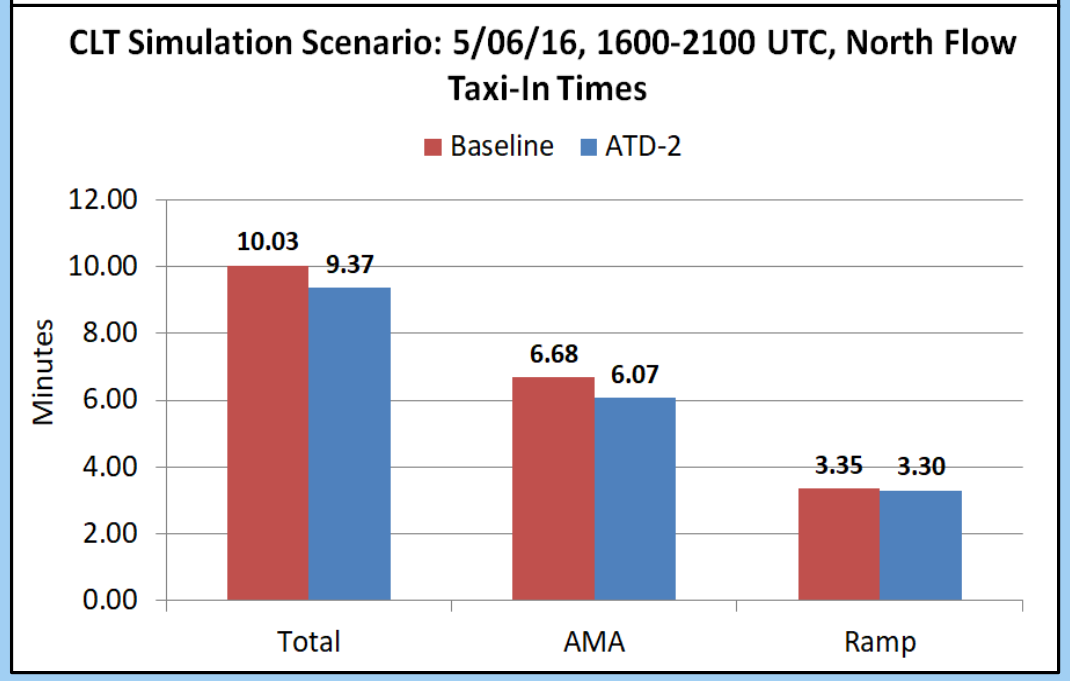


Impact on Taxi-In Times

Sim #1: 06/15/2016
South Flow
1000-1600 UTC

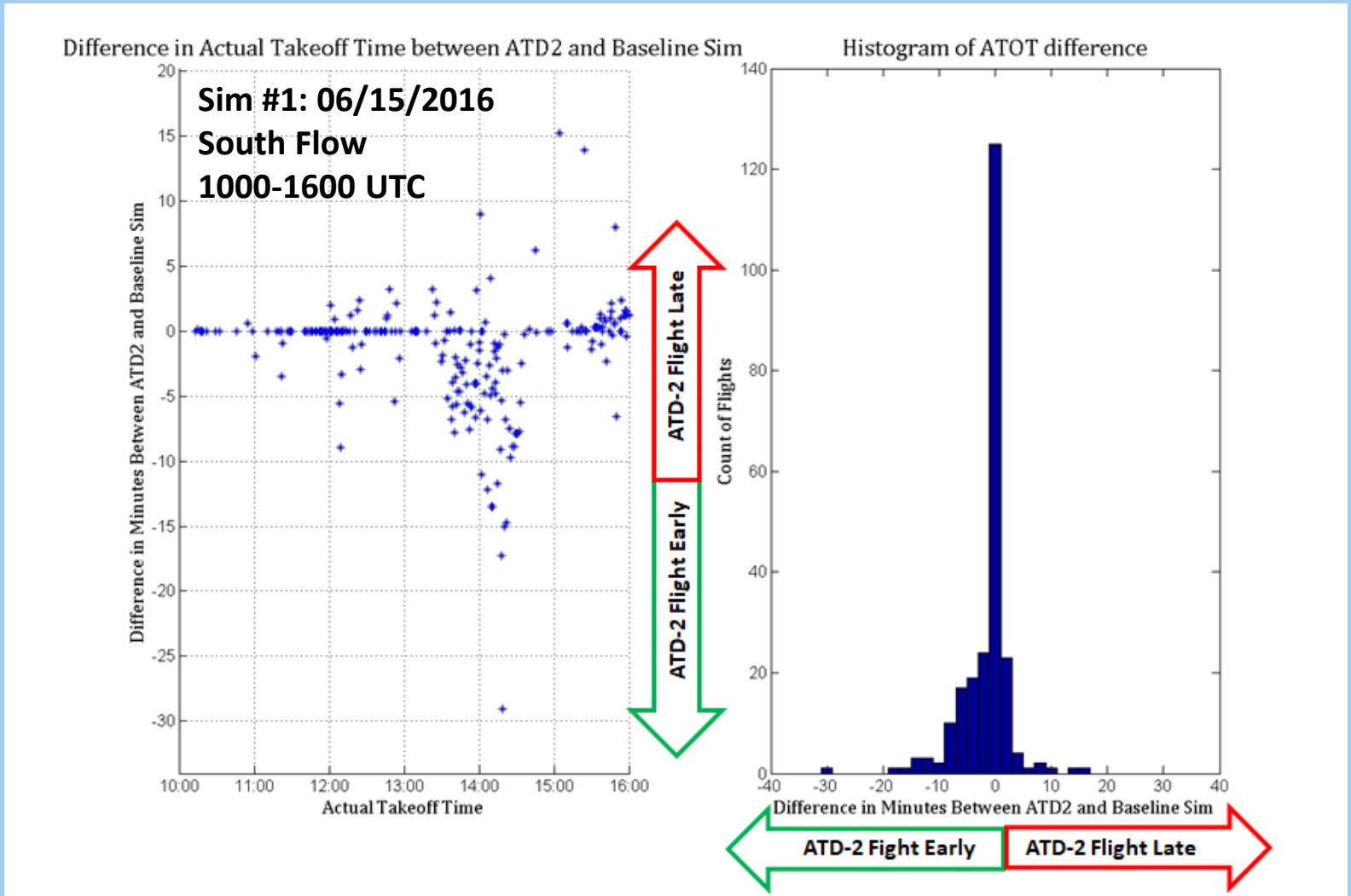


Sim #2: 05/06/2016
North Flow
1600-2100 UTC



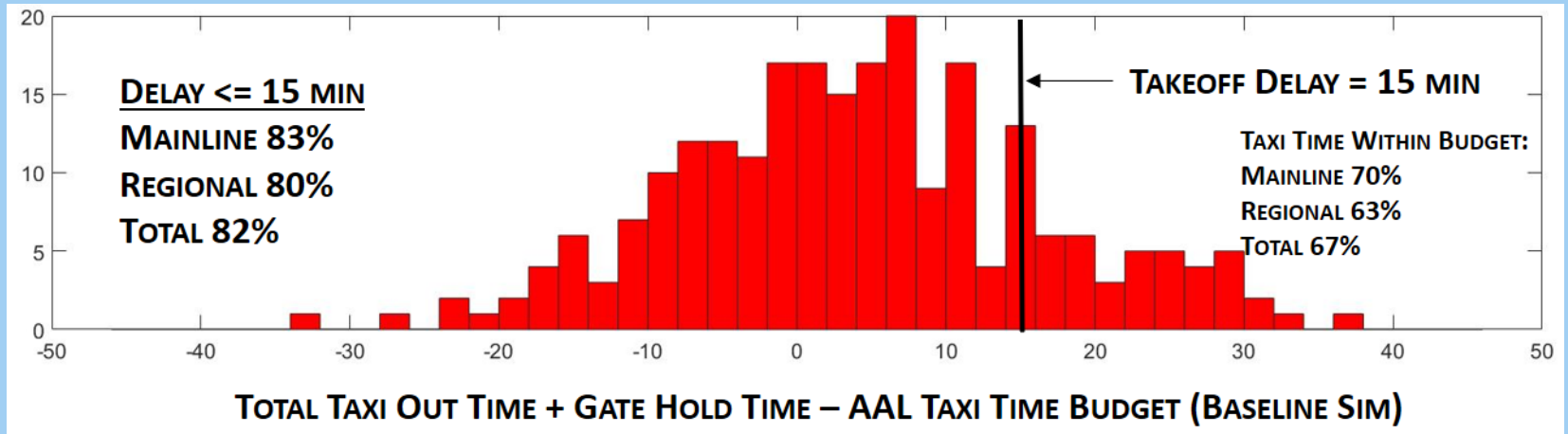
Impact on OFF-Time Performance

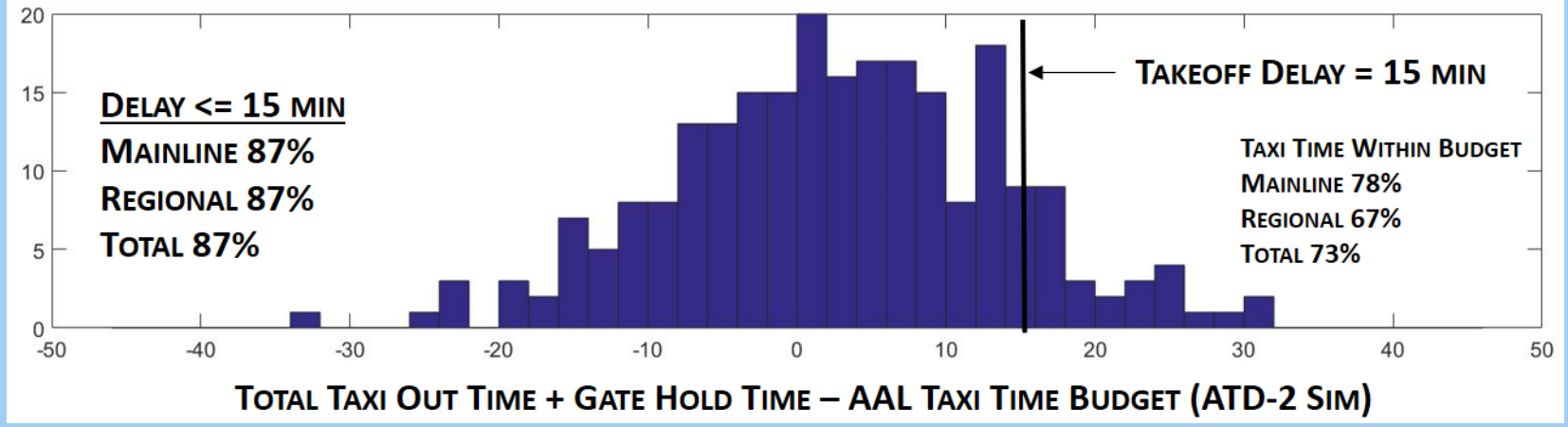
Simulated Takeoff Time Difference
ATD-2 Sim Flight – Baseline Sim Flight



Impact on OFF-Time Peformance

Simulated Takeoff Time as compared to SOBT + AAL Taxi Budget
Simulated Taxi Out Time as compared to AAL Budget





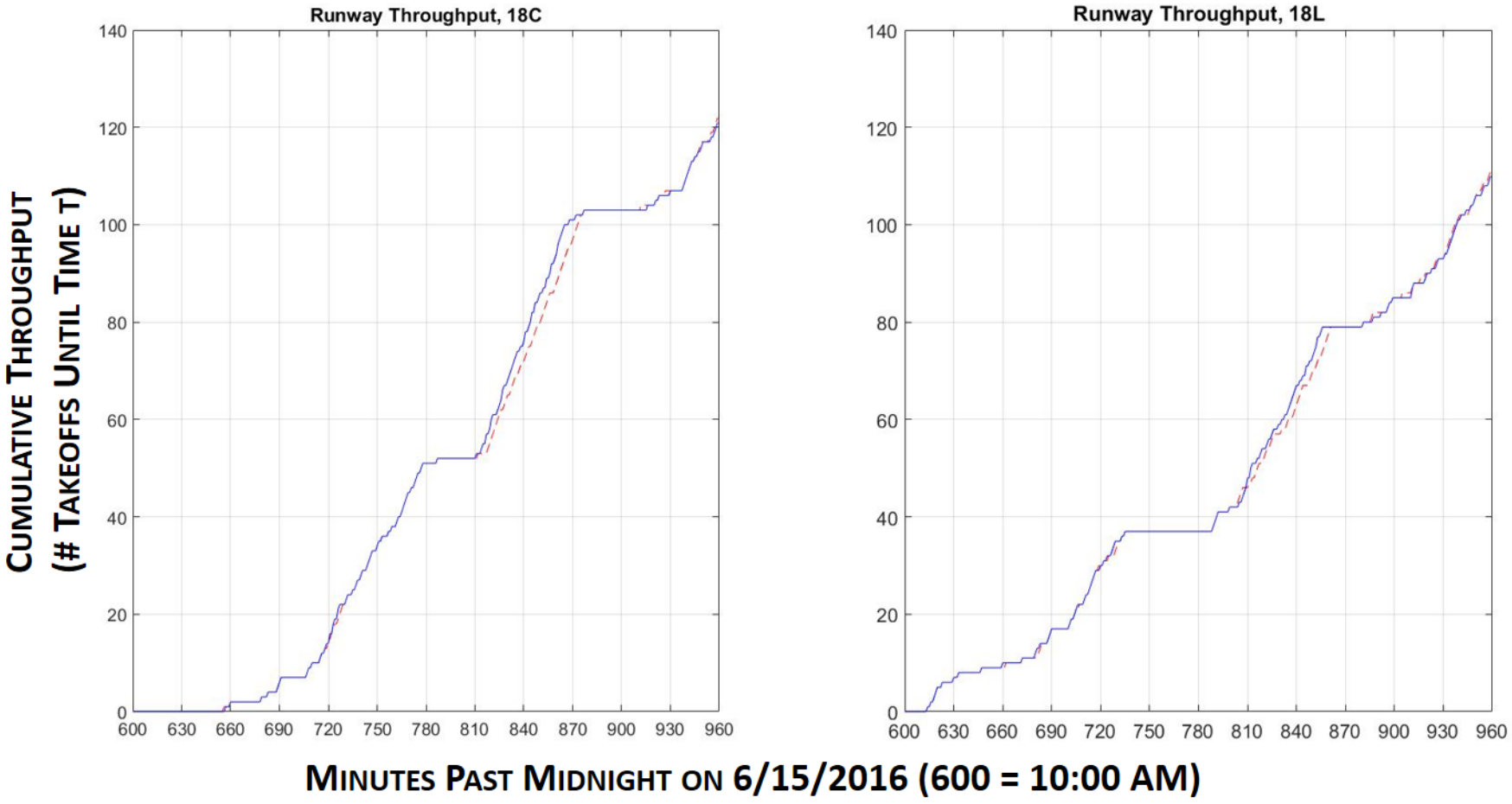
Impact on Airport Throughput

Cumulative Runway Takeoff Counts

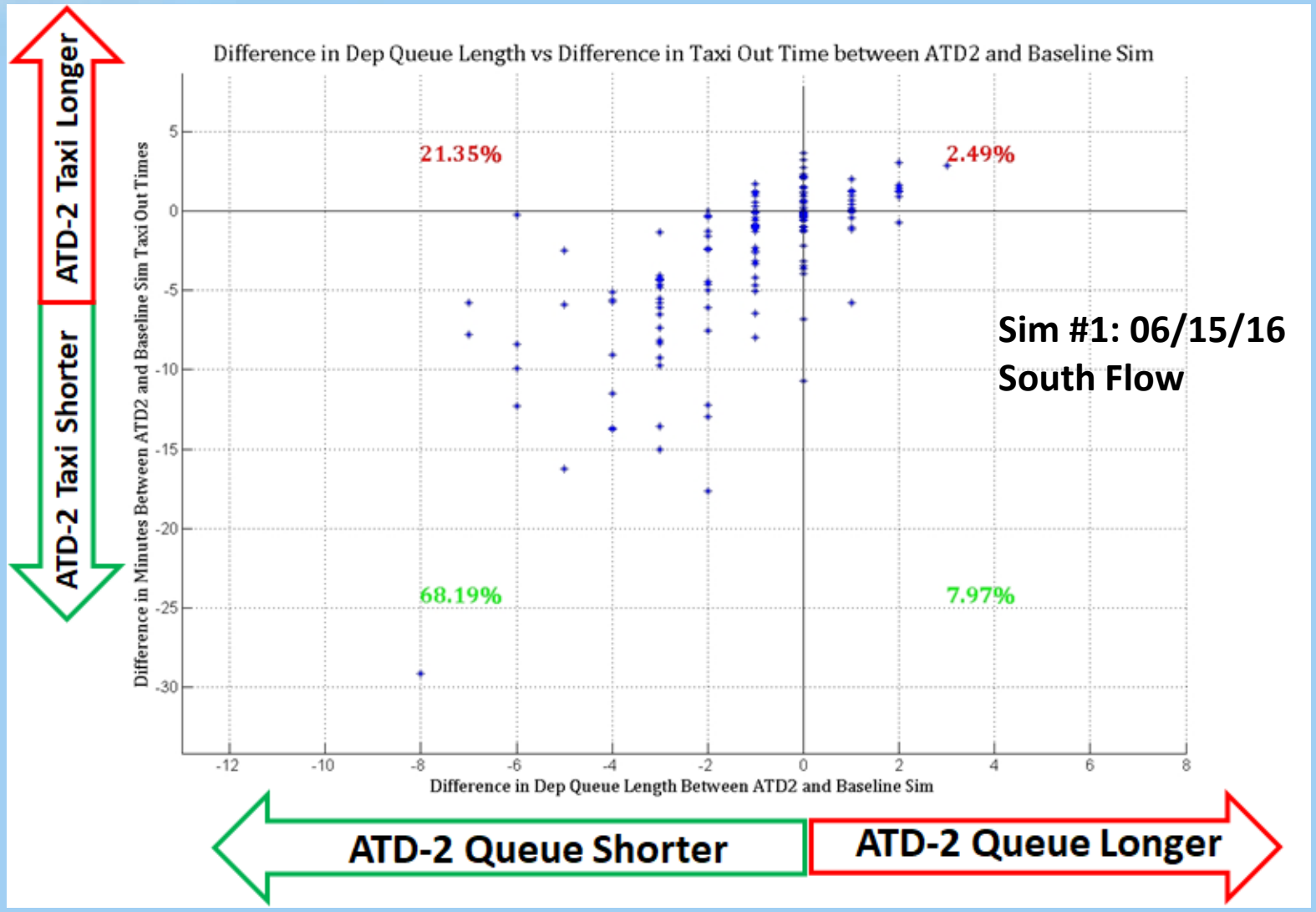
Red – Baseline (current-day) operations

Blue – ATD-2 operations

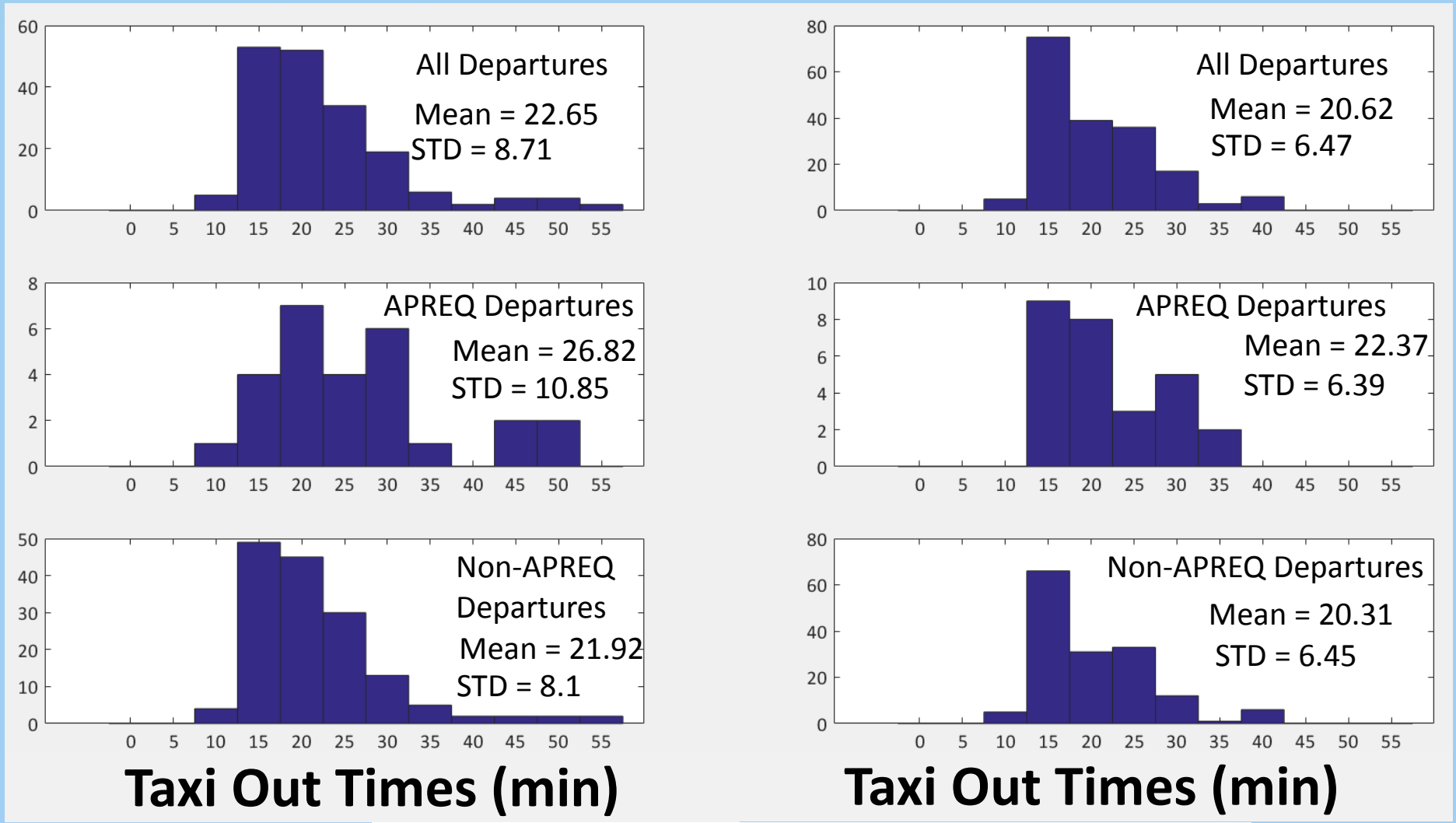
Sim #1: 06/15/16
South Flow



Benefit Mechanism: Demand Throttling

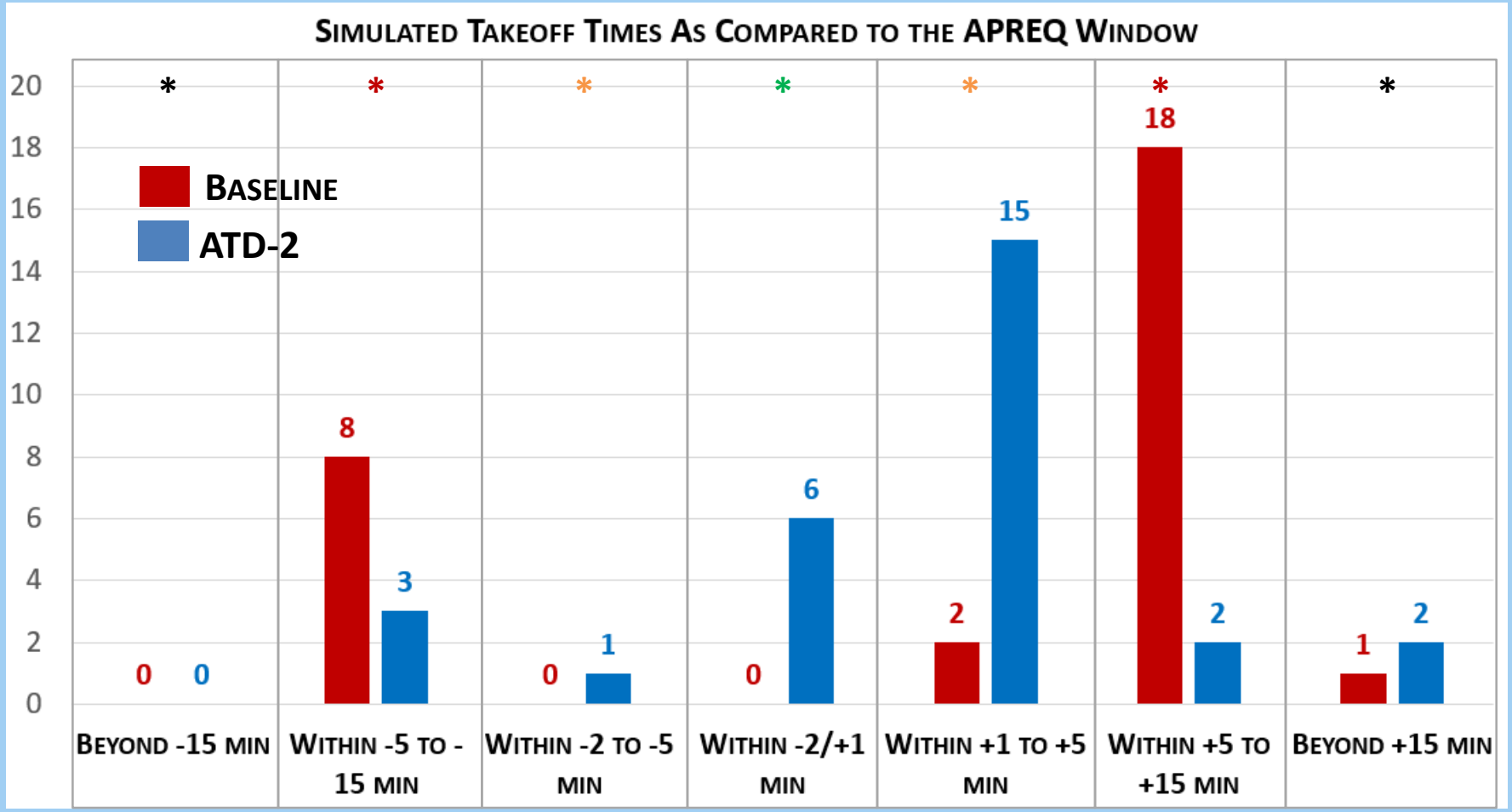


Benefit Mechanism: APREQ Coordination



Sim #2: 05/06/2016, North Flow, 1600-2100 UTC

Benefit Mechanism: TMI Compliance



Sim #1: 06/15/16, South Flow