

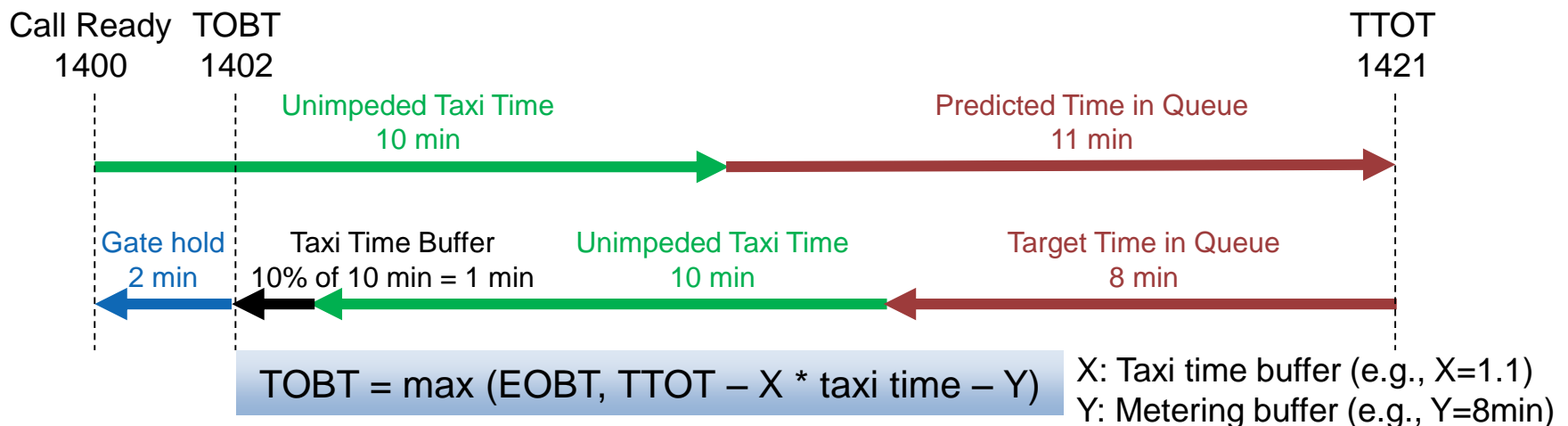
Initial Data Analysis Results for ATD-2 ISAS HITL Simulation

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- Objectives
 - To evaluate operational procedures and information requirements for
 - **Tactical Surface Metering Tool**
 - APREQ procedures between ATC Tower and Center
 - Data exchange elements between Ramp and ATC Tower
- Scenarios
 - IFR rules in clear weather at Charlotte airport (CLT)
 - No GA / cargo flights
 - TMI flights included: APREQ/CFR, EDCTs, and MIT
 - North flow: 68 departures and 85 arrivals, with 3 turnaround
 - South flow: 63 departures and 89 arrivals, with 4 turnaround

- Provides pushback advisories to ramp controllers
- Departure demand control
 - Absorb delay in AMA and Ramp area by adding buffers in computing pushback time (TOBT)
 - Prevent runway over-saturation or starvation
 - Prevent too much or too little gate hold
 - Implement tunable parameters to maintain pressure on runway queue depending on demand/capacity

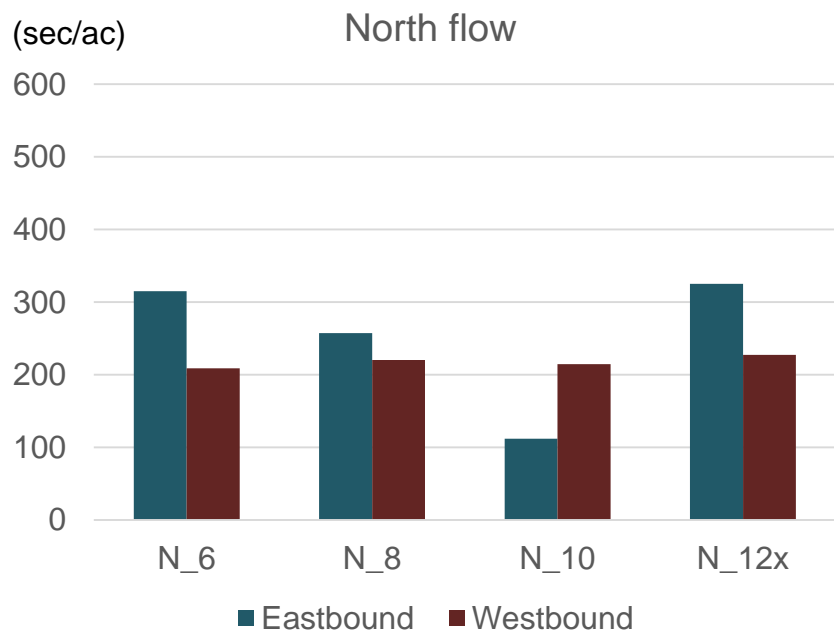


- Total eight runs having different runway configuration, metering buffer value, and MIT constraint conditions
 - Different durations, leading to different numbers of flights

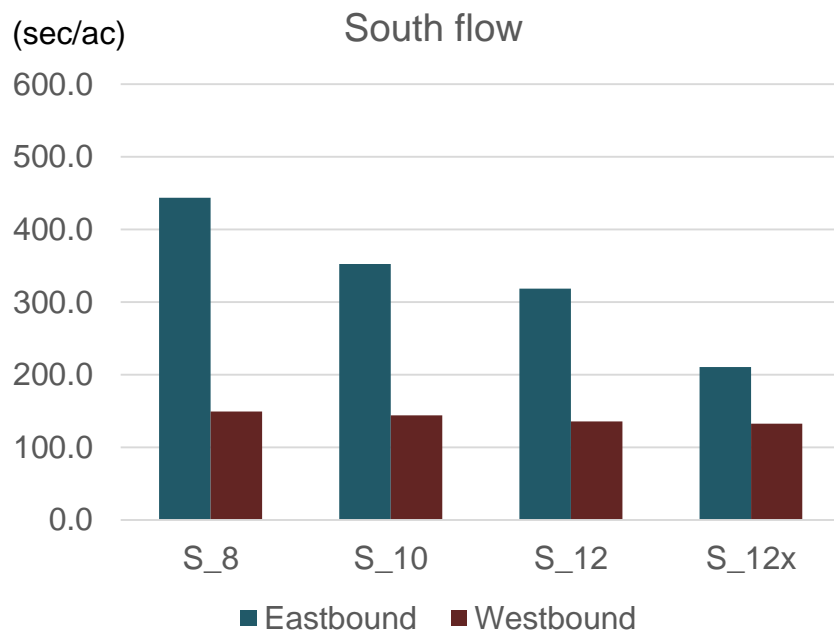
Run Name	Runway Configuration	Metering Value (min)	MIT Restriction	Duration (sec)	Dep No (OFF)	Arr No (IN)
N_6	North flow	More hold 6	Yes	3536	35	34
N_8		8	Yes	3979	44	38
N_10		10	Yes	3014	27	26
N_12x		Less hold 12	No	4034	54	50
S_8	South flow	More hold 8	Yes	3204	42	28
S_10		10	Yes	3145	41	34
S_12		12	Yes	3332	49	39
S_12x		Less hold 12	No	3380	49	43

- Gate hold time
- Taxi times
 - Ramp area and AMA
 - Eastbound and Westbound
- Runway throughput
 - Accumulated takeoffs
- Surface congestion
 - Number of departures in AMA and ramp area
 - Departure queue length and average queue time
- Traffic Management Initiatives (TMI)
 - APREQ and EDCT flights

- Mean gate hold times by runway
 - Based on the given EOBT times and actual out times
 - All departures taken off, including TMI flights
 - More holding with the lower metering value for Eastbound

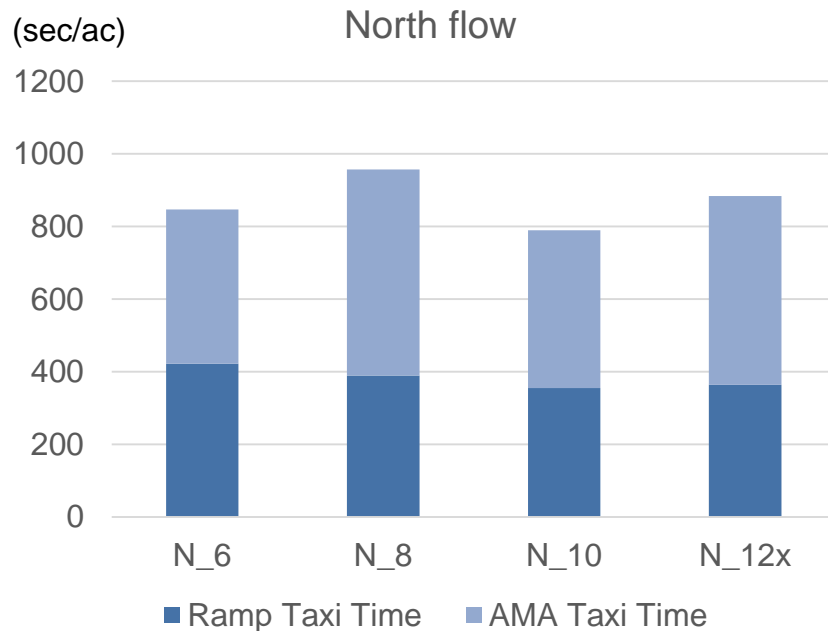


Dep No	15 20	17 27	14 13	20 34
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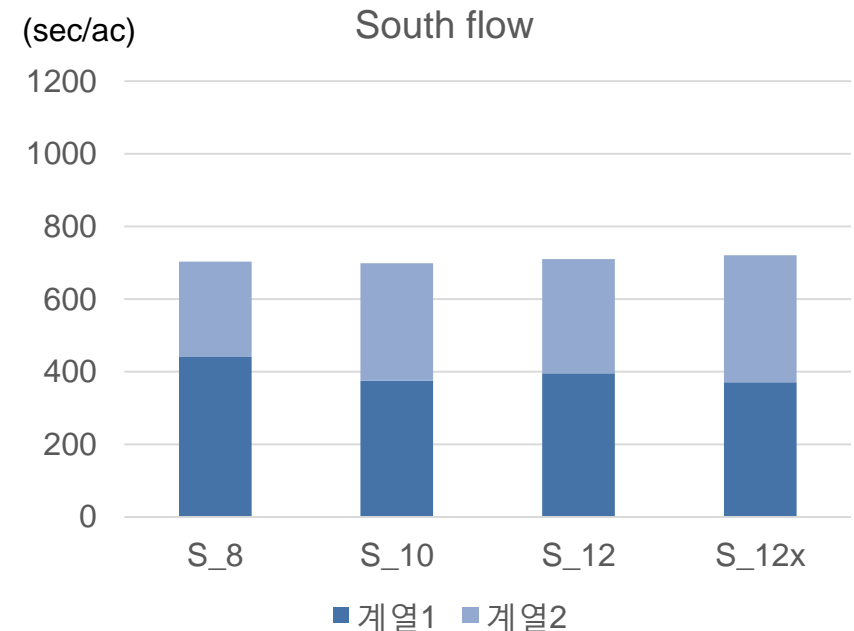


Dep No	24 18	20 21	28 21	28 21
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- Mean taxi-out times by metering value
 - No significant impact by metering value
 - Affected by other factors such as run duration, runway changes, and TMI constraints

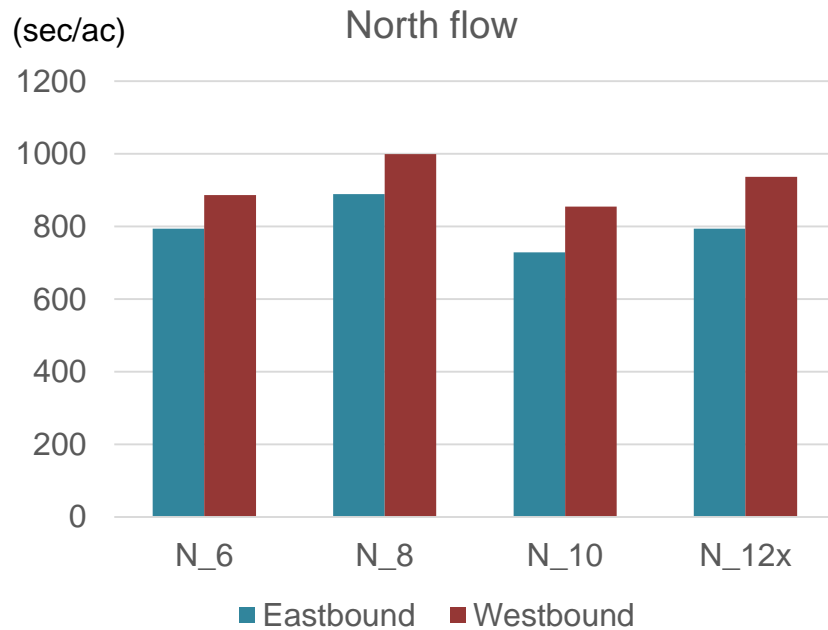


Dep No	35	44	27	54
Runway Change	9	9	4	12

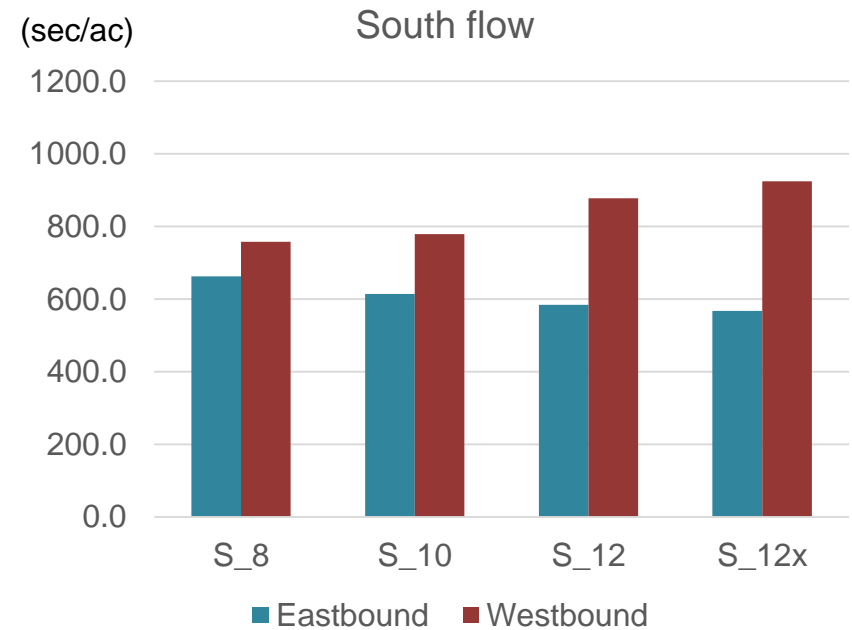


Dep No	42	41	49	49
Runway Change	8	7	8	11

- Mean taxi-out times by runway
 - Longer taxi distance for Westbound flights

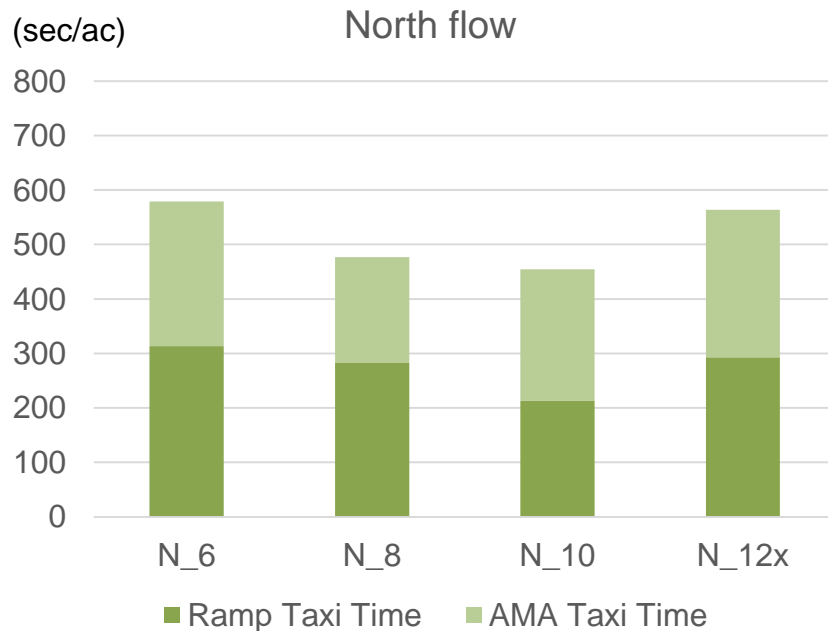


Dep No	15 20	17 27	14 13	20 34
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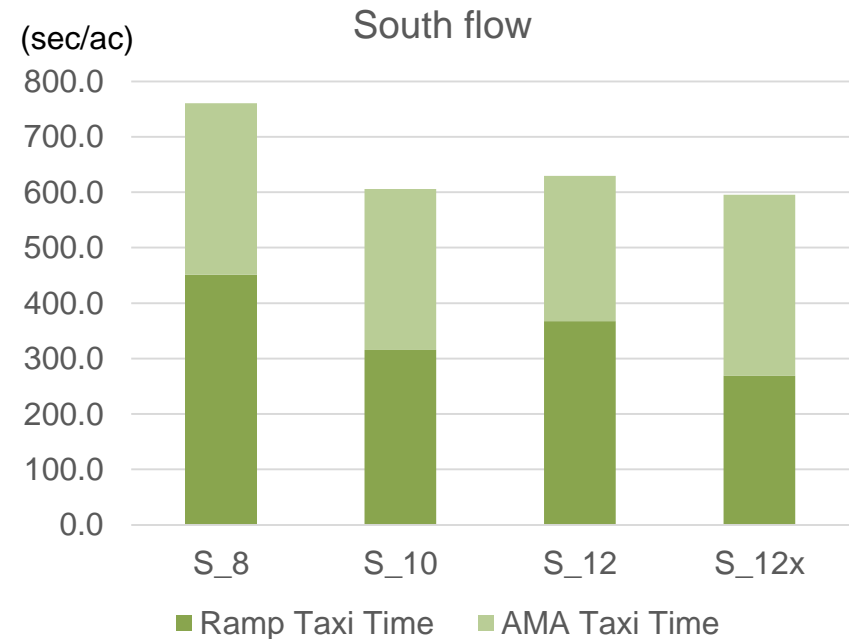


Dep No	24 18	20 21	28 21	28 21
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- Mean taxi-in times by metering value
 - All arrivals that reached gates
 - More holding at gate can increase taxi-in times due to gate conflicts.

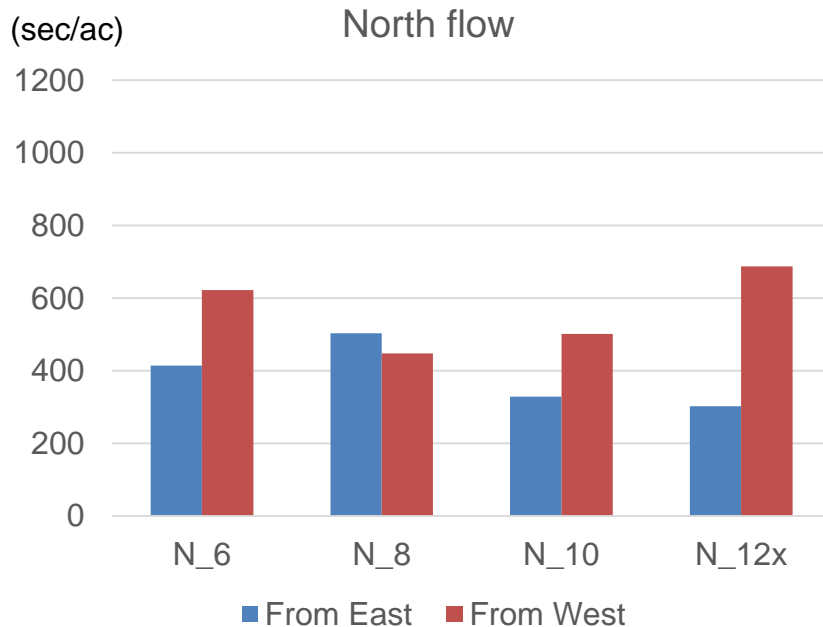


Arr No	34	38	26	50
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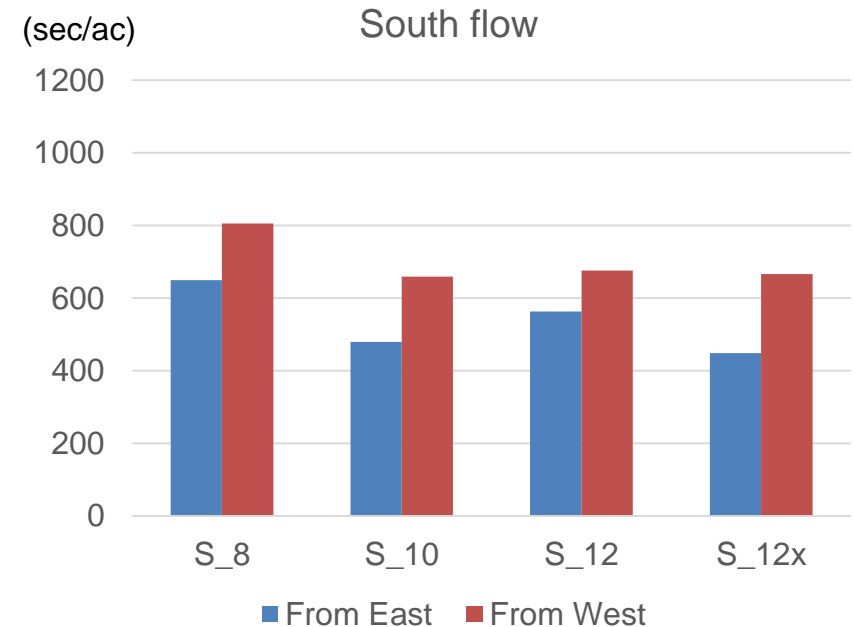


Arr No	28	34	39	43
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- Mean taxi-in times by runway
 - Affected by other factors such as run duration, runway changes, and interaction with departures

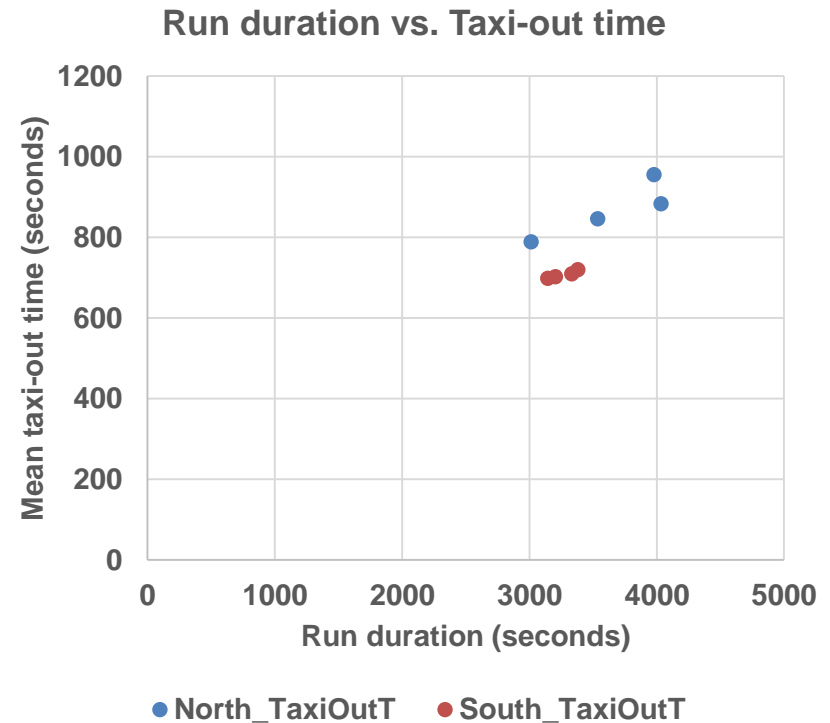
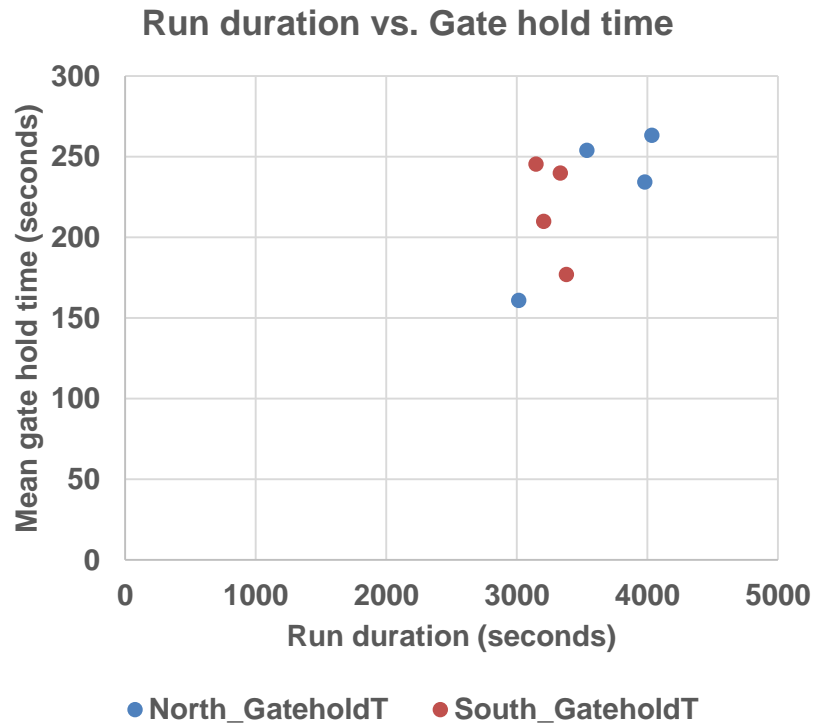


Arr No	7 27	20 18	7 19	16 34
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Arr No	8 20	10 24	16 23	14 29
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- Mean values of gate hold times and taxi-out times look proportional to run durations.



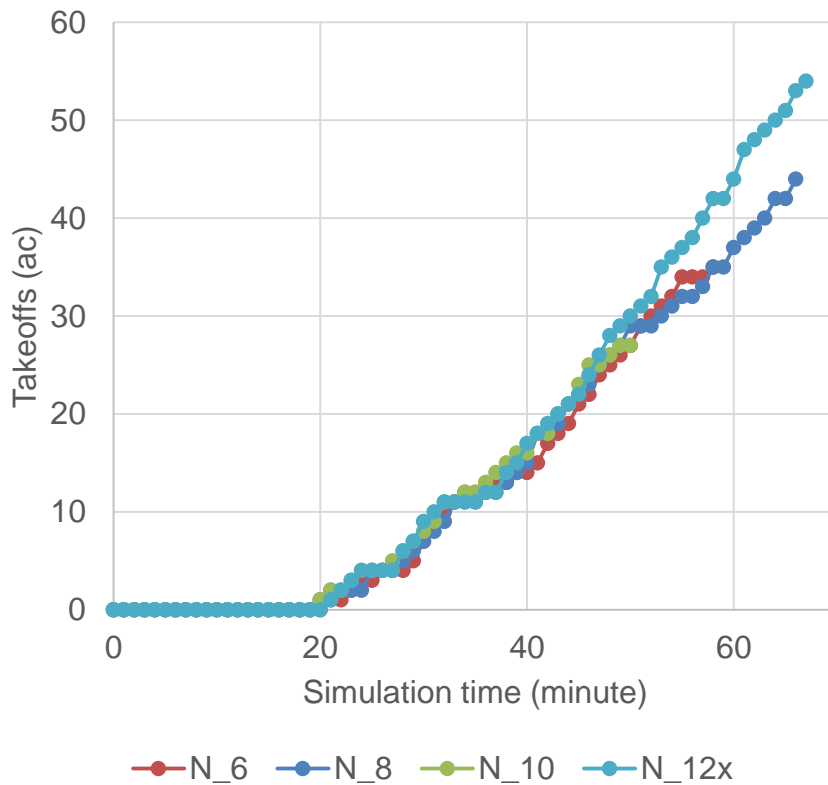
- Runway changes from schedule to actual assignment can impact the airport performance.

North flow	N_6	N_8	N_10	N_12x
36R (Eastbd)	33 -> 24	33 -> 24	33 -> 29	33 -> 27
36C (Westbd)	35 -> 44	35 -> 44	35 -> 39	35 -> 41
36R -> 36C	9	9	4	9
36C -> 36R	0	0	0	3
Total	9	9	4	12

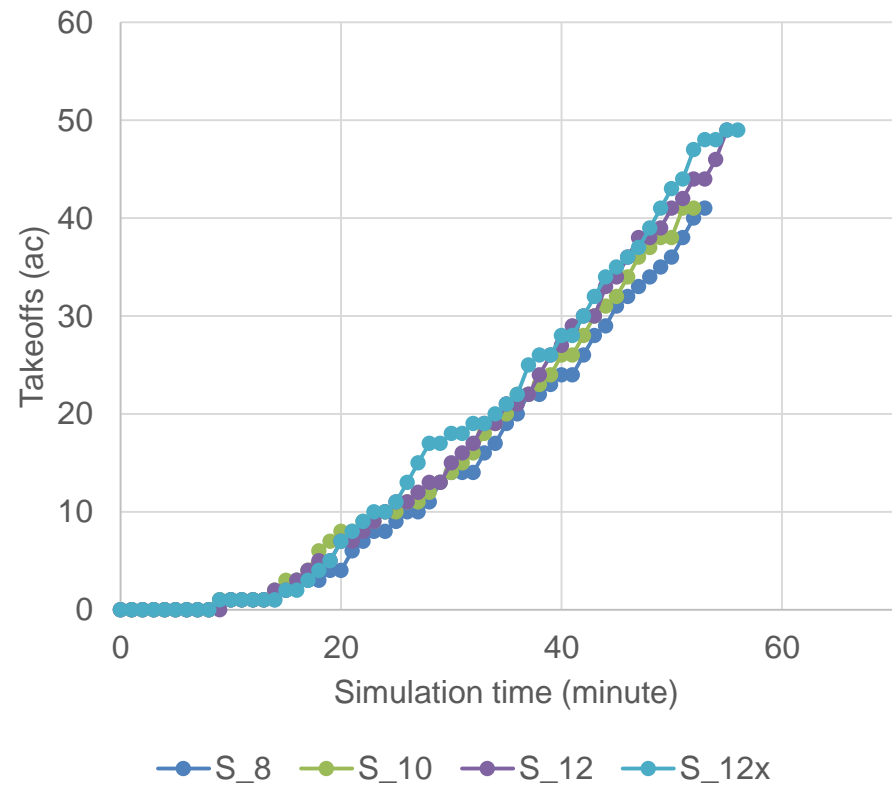
South flow	S_8	S_10	S_12	S_12x
18L (Eastbd)	41 -> 39	41 -> 36	41 -> 39	41 -> 34
18C (Westbd)	22 -> 24	22 -> 27	22 -> 24	22 -> 29
18L -> 18C	5	6	5	9
18C -> 18L	3	1	3	2
Total	8	7	8	11

- Accumulated takeoffs
 - Similar takeoff rates, except for No MIT cases

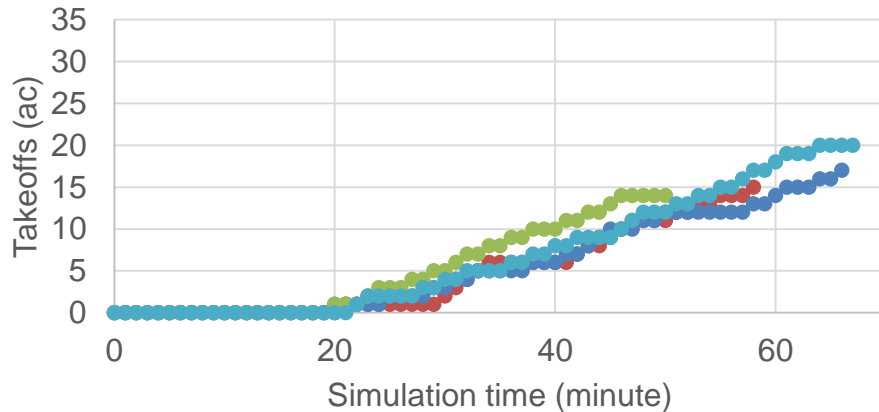
Accumulated takeoffs - North flow



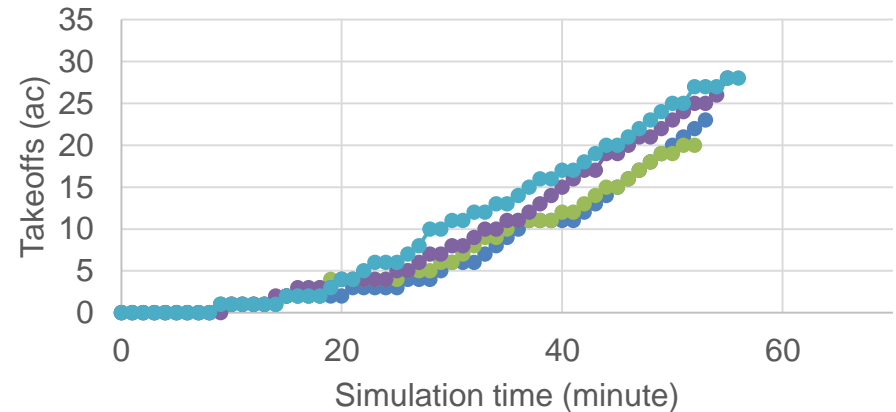
Accumulated takeoffs - South flow



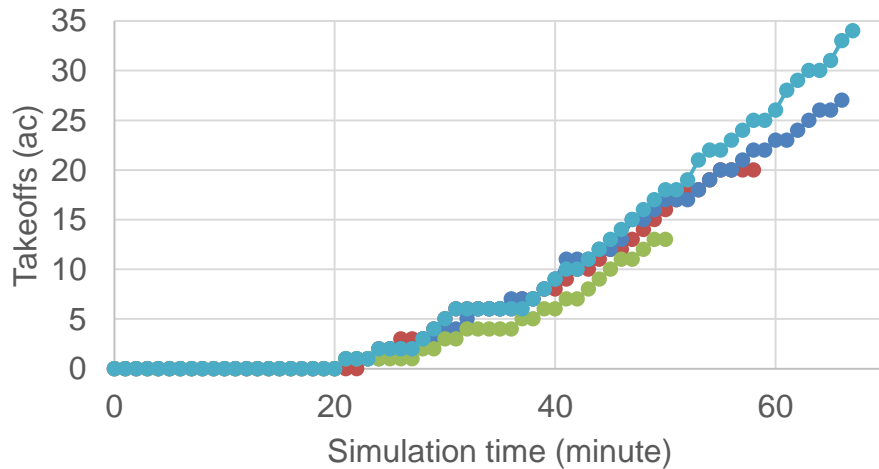
Accumulated takeoffs on 36R - North flow



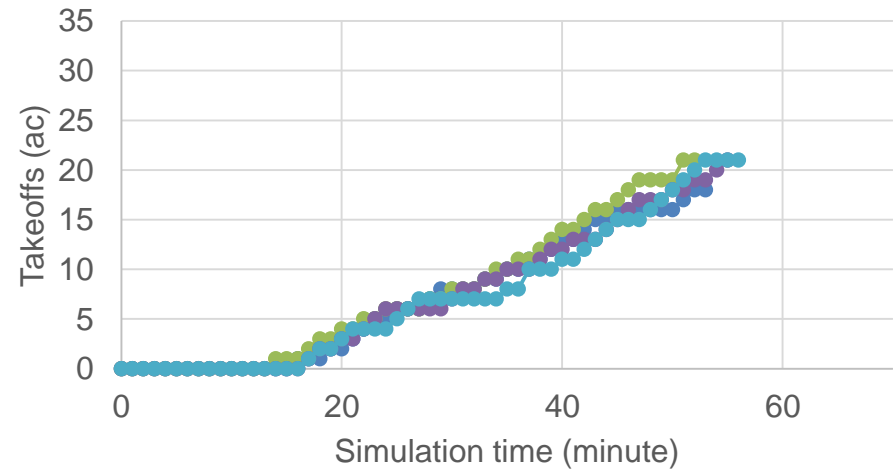
Accumulated takeoffs on 18L - South flow



Accumulated takeoffs on 36C - North flow



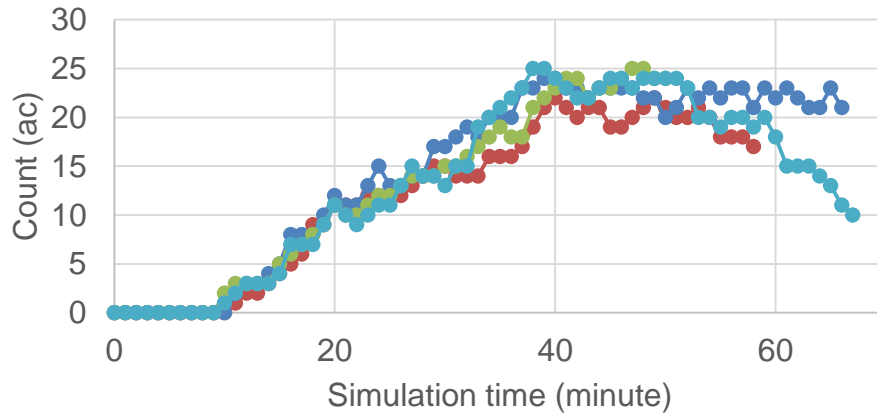
Accumulated takeoffs on 18C - South flow



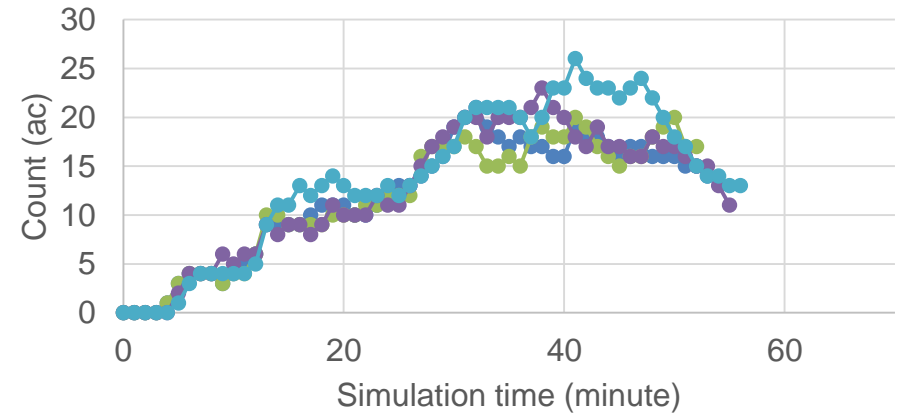
—●— N_6 —●— N_8 —●— N_10 —●— N_12x

—●— S_8 —●— S_10 —●— S_12 —●— S_12x

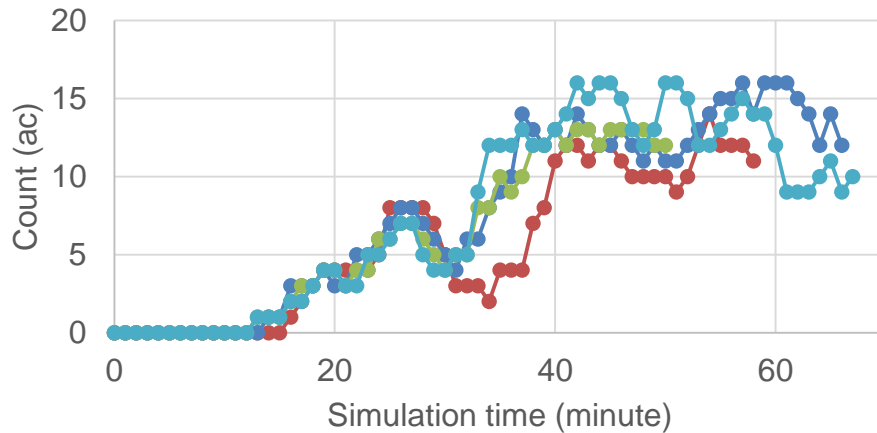
Surface count - North flow



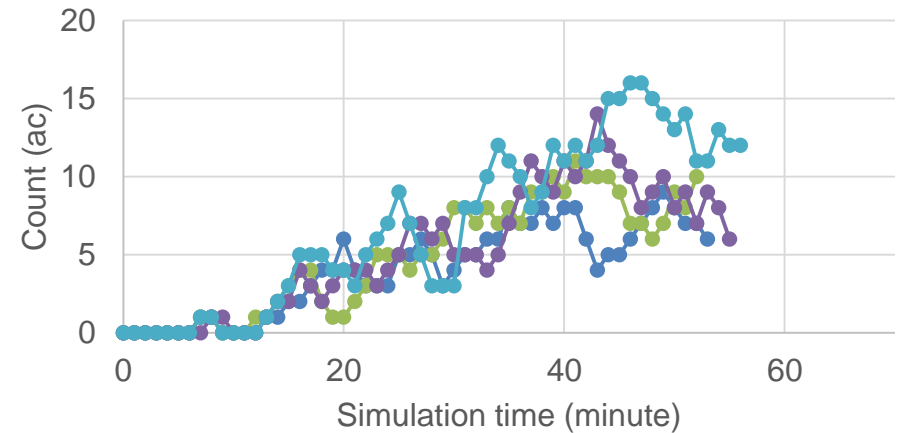
Surface count - South flow



AMA count - North flow



AMA count - South flow

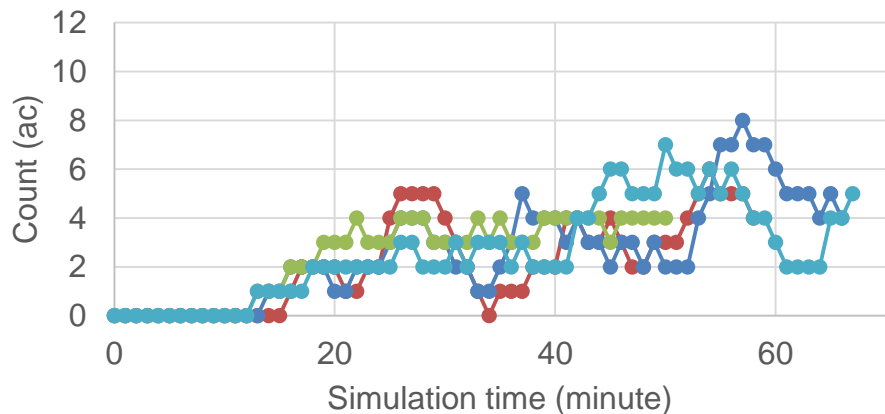


—●— N_6 —●— N_8 —●— N_10 —●— N_12x

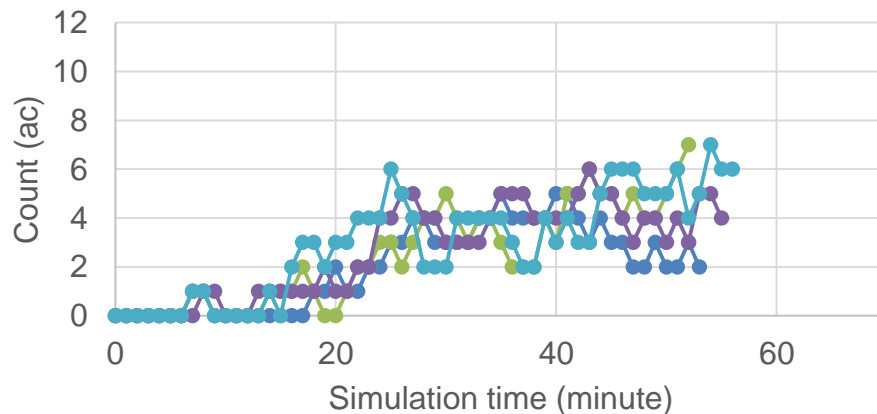
—●— S_8 —●— S_10 —●— S_12 —●— S_12x

Queue Size by Runway

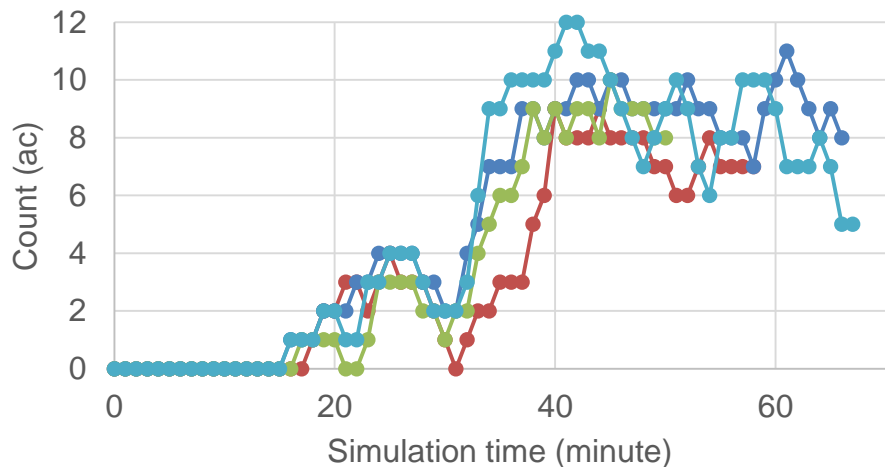
AMA count to 36R - North flow



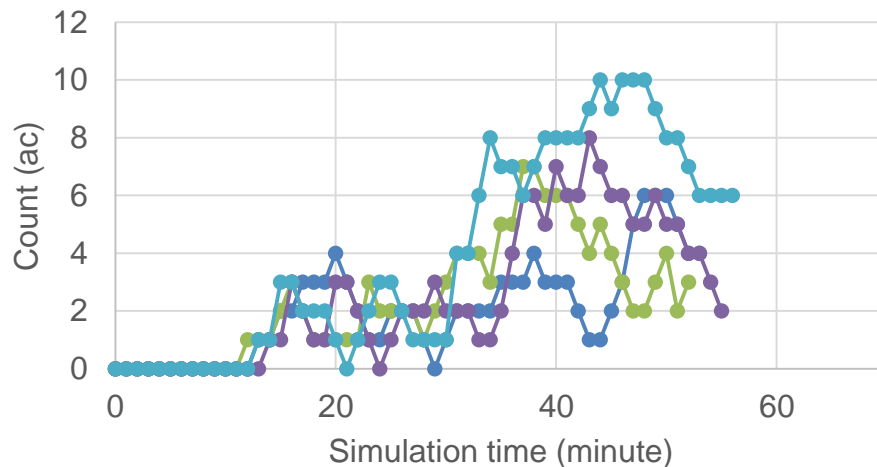
AMA count to 18L - South flow



AMA count to 36C - North flow



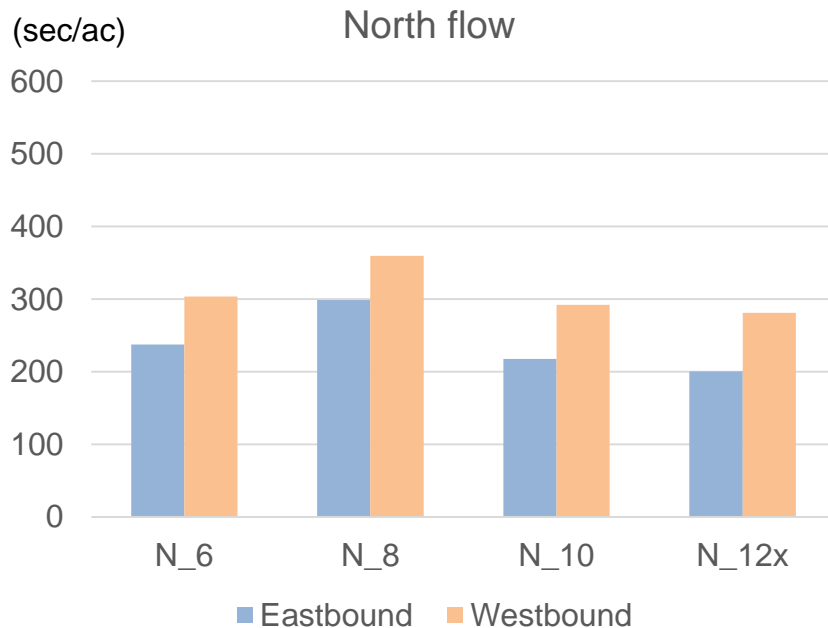
AMA count to 18C - South flow



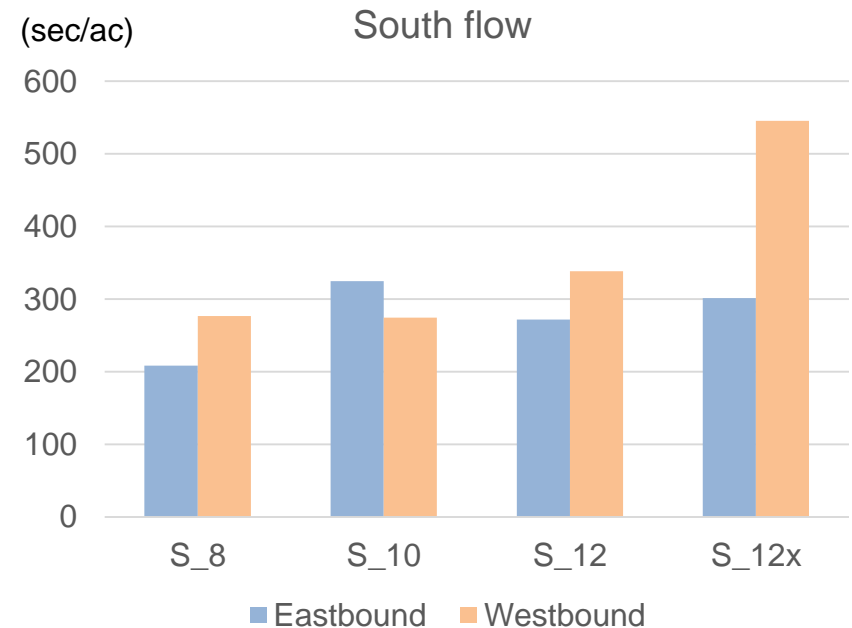
—●— N_6 —●— N_8 —●— N_10 —●— N_12x

—●— S_8 —●— S_10 —●— S_12 —●— S_12x

- Mean queue time per aircraft by runway
 - (Sum of waiting times in queue during simulation run) / (Number of departures taken off)
 - Expected longer queue time with the higher metering value

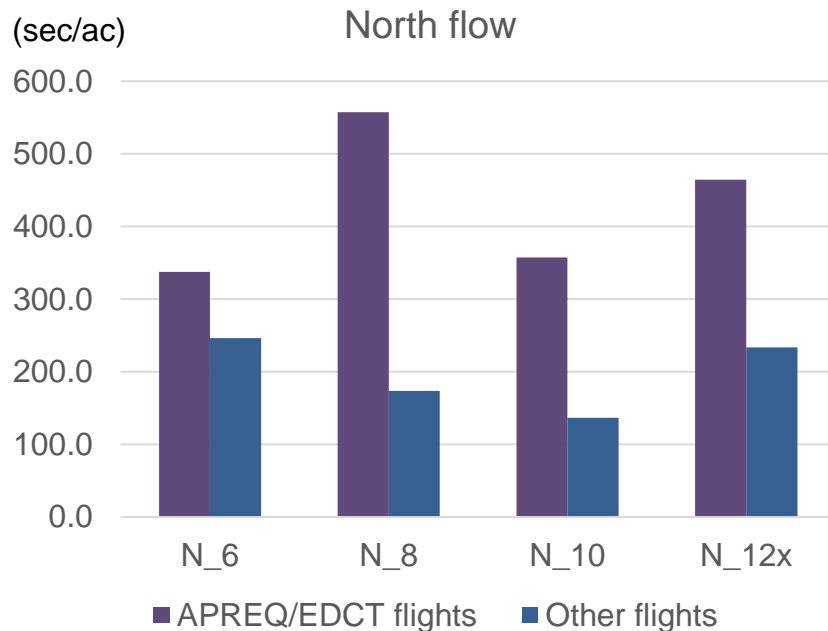


Dep No	15 20	17 27	14 13	20 34
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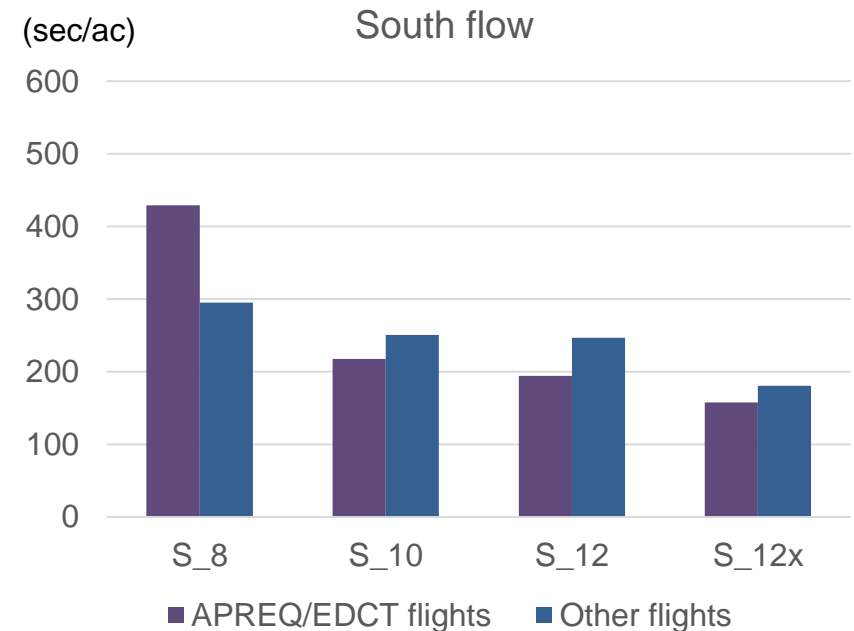


Dep No	24 18	20 21	28 21	28 21
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- Mean gate hold time comparison
 - TMI flights try to meet Controlled Takeoff Time (CTOT), whereas other flights follow pushback advisories (TTOT).
 - Different number of TMI flights for each run can affect.

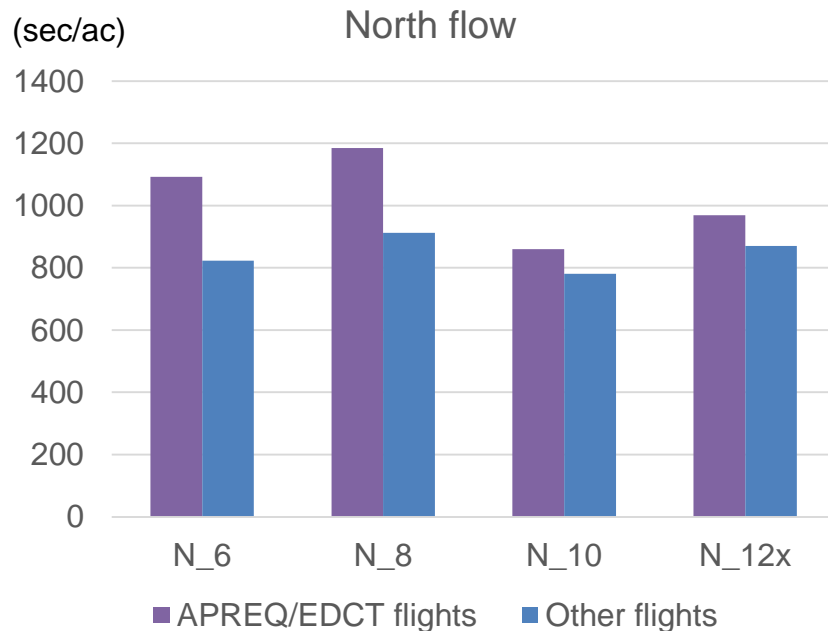


Dep No	3 32	7 37	3 24	7 47
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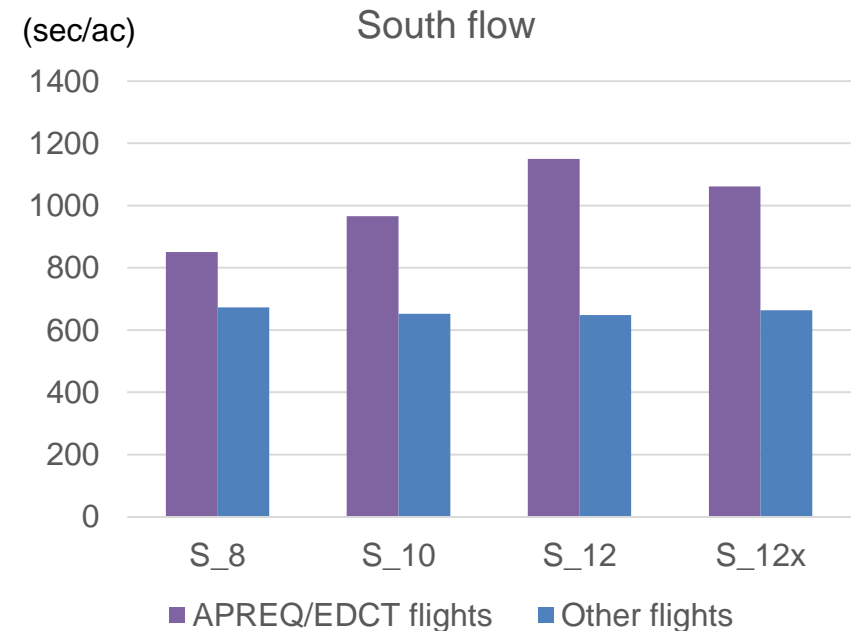


Dep No	7 35	6 35	6 43	7 42
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- Mean taxi-out time comparison
 - Longer taxi time for TMI flights, compared to other flights
 - For South flow, longer taxi time for TMI flights along with the higher metering value (less hold, longer queue)



Dep No	3 32	7 37	3 24	7 47
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Dep No	7 35	6 35	6 43	7 42
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- A HITL simulation was conducted to evaluate a tactical surface metering tool for ramp controllers at CLT.
- As the metering value increases, less gate holding and longer taxi times in departure queues were expected, but the simulation results might be affected by other factors:
 - Runway changes
 - Run duration
 - TMI flights
- APREQ/EDCT flights tends to have longer taxi times to meet the given takeoff times.