



Evaluation of a Tactical Surface Metering Tool for Charlotte Douglas International Airport via Human-in-the-Loop Simulation

DASC

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- Background
 - The Challenge
 - Previous Research
 - ATD-2's Metering Tool
- Objectives of Study
- Tactical Surface Metering Tool
- Experiment Details
- Results
- Summary

The Challenge



Surface Congestion



Long Runway Queue

Loss of Predictability

Will Departure/Surface Metering help?

FLIGHT	DEPARTING TO	TIME	GATE	STATUS
1589	Charlotte	12:55p	3	On time
907	Phoenix	1:50p	19	At 2:00 pm
3075	Cleveland	2:10p	8	On time
6154	Washington	2:16p	9A	On time
6484	Detroit	2:25p	18	On time
642	Baltimore	2:30p	21	On time
2088	Philadelphia	2:40p	17	On time
539	Orlando	3:30p	19	At 3:35 pm
1845	Philadelphia	3:30p	5	On time
1312	Baltimore	3:30p		
5389	Detroit	4:00p		
422	Baltimore	4:00p		
933	Tampa	4:50p	19	On time

FLIGHT	DEPARTING TO	TIME	GATE	STATUS
1154	Chicago	5:40p	21	At 6:00 pm
5957	Cleveland	5:45p	8	On time
1979	Philadelphia	5:50p	5	On time
4686	New York	6:05p	1	On time
4221	Washington	6:12p	11	On time
178	Baltimore	6:15p	17	On time
1016	Atlanta	6:26p	16	On time
4220	Detroit	6:44p	18	On time

FLIGHT	ARRIVING FROM	TIME	GATE	STATUS
1588	Charlotte	12:04p	3	At 1:41 pm
3075	Newark	1:35p	8	Arrived
6046	Washington	1:44p	9A	At 2:00 pm
642	Fort Lauderdale	1:55p	21	Arrived
6484	Detroit	2:00p		Arrived
2001	Baltimore	2:15p	17	On time
1842	Philadelphia	2:54p	5	On time
	Orlando	2:55p	21	At 3:05 pm
	Chicago	3:05p	19	At 3:10 pm
	Detroit	3:57p		At 4:10 pm

Previous Research on Metering Tool



- Strategic Metering Tool at JFK (Stroiney et. al. 2013)
 - Schedules provided two hours in advance
 - Taxi out benefits ranged from 1.5 to 2.7 min per flight
- Spot and Runway Departure Advisor (SARDA) (Jung, Malik, Gupta & Hayashi, 2014)
 - Tactical in nature, schedules for the next 15 min
 - Benefits to taxi times were shown for both DFW and CLT
 - SARDA did not use ready times or Earliest Off Block Times (EOBT) or Ration By Schedule (RBS) principles for creating schedules

Need a tactical metering tool that can be extended to include strategic scheduling

ATD-2's Metering Tool



- Does not control capacity, just estimates it
- Provides advisories that throttle demand to the runway during surface metering
 - Earliest off block times are used to estimate demand at any given time.
 - The tool does not double delay flights subject to FAA restrictions
 - Orders flights based on their accuracy of EOBTs, Priority, FAA restrictions, exempted flights
- Provides pushback advisories based on calculated Target Off Block Times (TOBT)

ATD-2 = Airspace Technology Demonstration-2

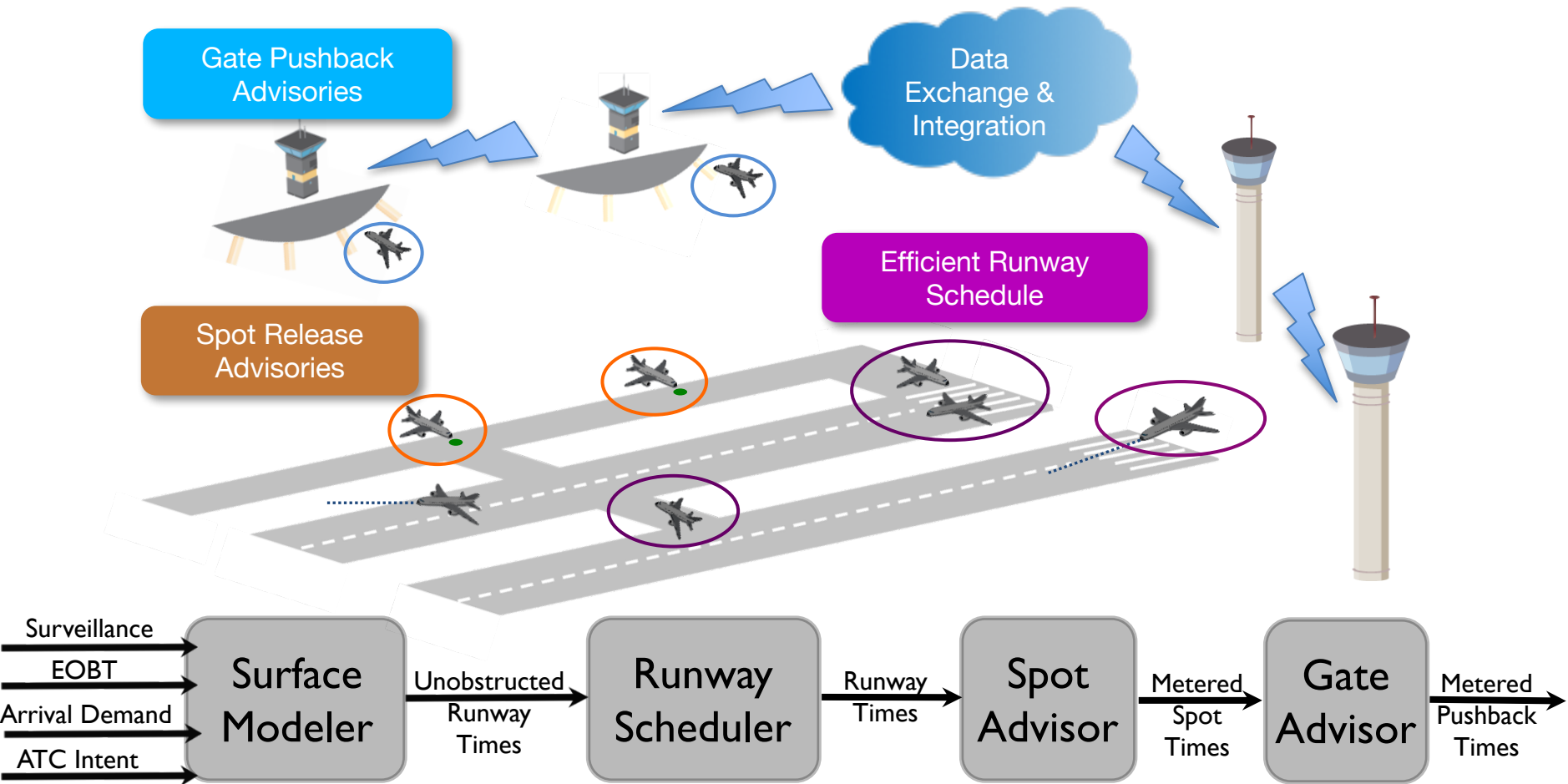
Objective of the Study



- Evaluate the Metering tool that provides recommended gate hold times or pushback advisories based on the formula:
$$\text{TOBT} = \max [\text{EOBT} , \text{TTOT} - \text{UTT} - \text{Metering Value}]$$
- Evaluate the Metering Value that is agreeable to both Airline Ramp and the ATC-Tower
 - Metering value is a buffer or excess queue time that could be taken at the gate or as taxi delay

EOBT= Earliest Off Block Time
TOBT= Target Off Block Time
TTOT = Target Take Off Time
UTT= Unobstructed Taxi Time

Tactical Surface Metering Concept



EOBT – Earliest OFF Block Times, RBS= Ration By Schedule

Metering Tool Advisories on User Interface



- Push advisory



EOBT < 10 min

- Gate Hold Advisory



EOBT < 10 min

- Hashtag: Click here to get an advisory



EOBT > 10 min

Experiment Details



- Experimental Matrix
- Scenario
- Participants
- Tools and Equipment

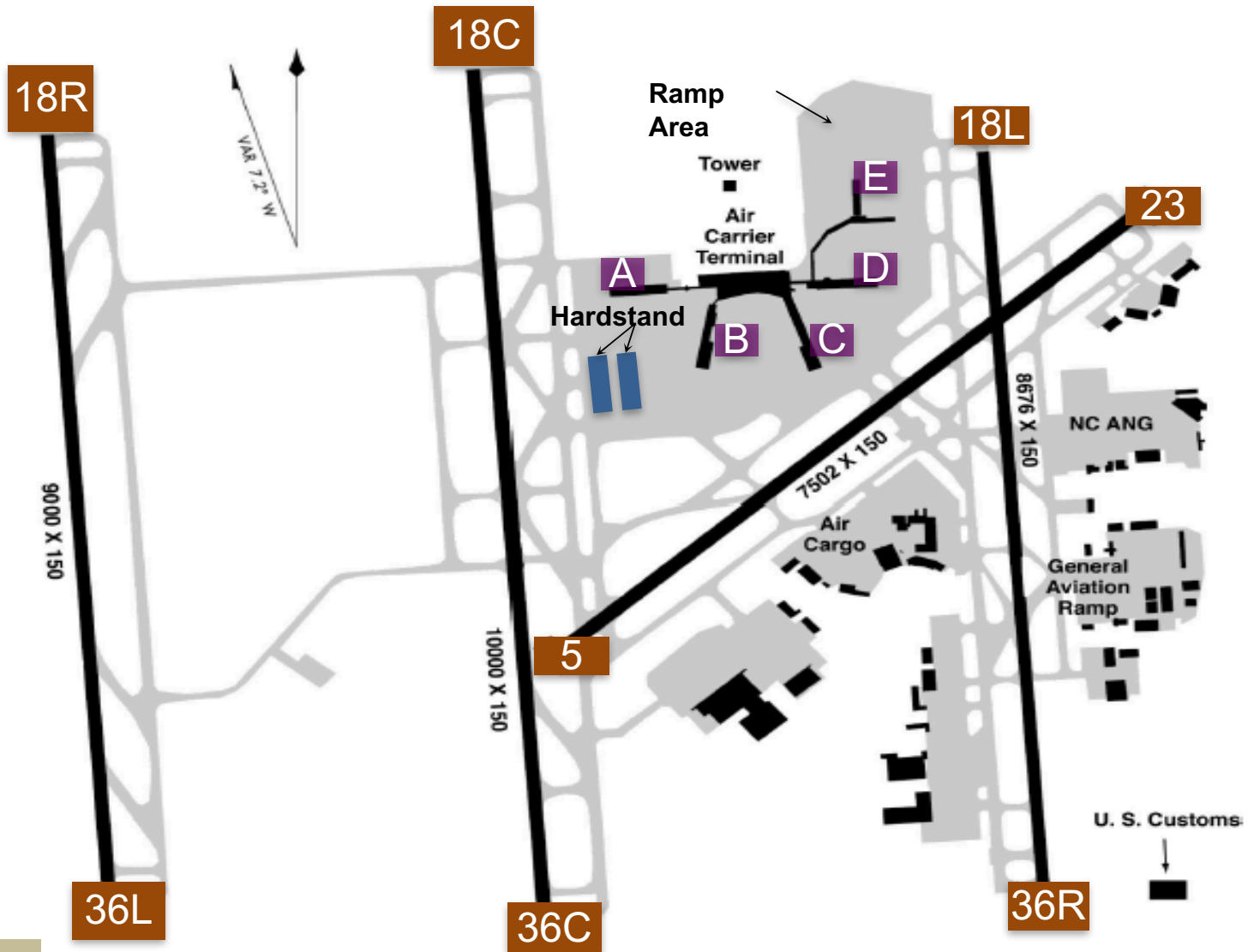
Experiment Matrix



- Two variables :
 - Metering Value / Level of Hold (3 levels)
 - Airport Configuration (2 levels)
- 3 x 2 matrix

Metering Value	Runway Configuration	
	North	South
8 min	N_8	S_8
10 min	N_10	S_10
12 min	N_12	S_12

Airport Map- Charlotte Douglas International



Traffic Scenario in CLT

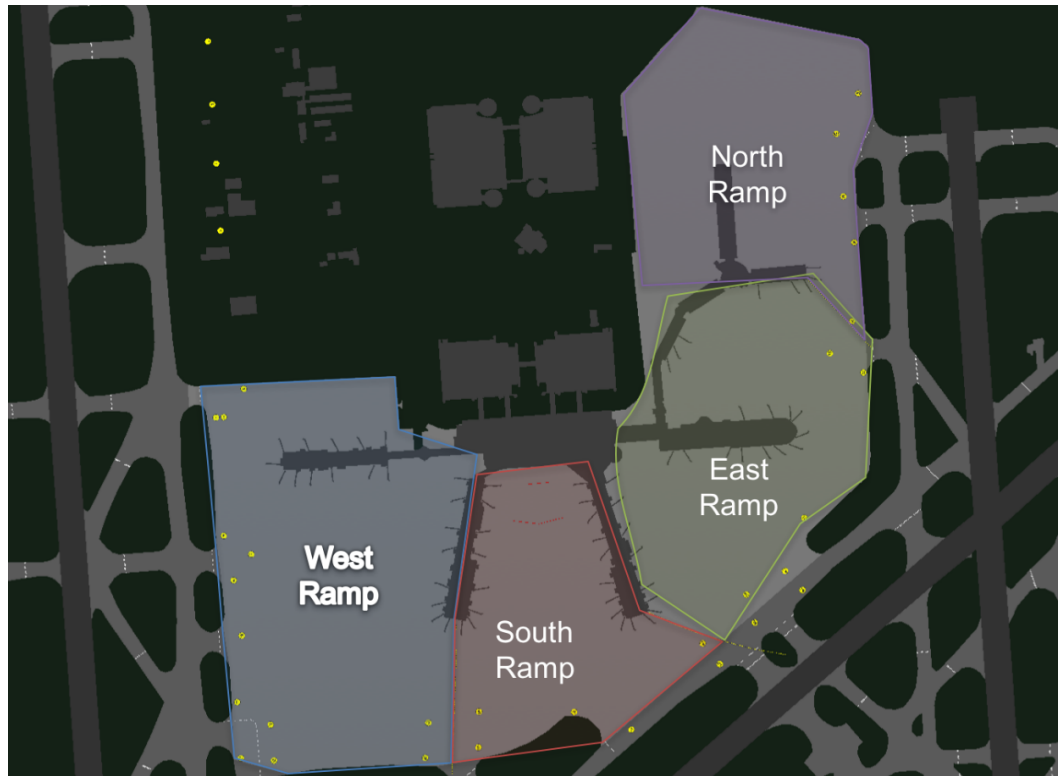


- South Dual Converging Operation
 - 92 arrivals & 80 departure per hour
- Triple North Operation
 - 75 arrivals & 65 departures per hour
- No wind, clear visibility, but IFR rules in effect
- No General Aviation flights
- No Cargo flights
- Duration 60 min

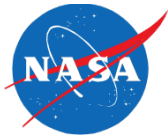
Participants



- Four Ramp Controllers – two active and two retired controllers
- One Ramp Manager
- Five Pseudo pilots as confederates



Tools & Equipment



- Ramp Control Tower to emulate Charlotte
 - 360 degree Simulator at Future Flight Central (FFC)
 - Ramp Traffic Console (RTC) & Ramp Manager Traffic Console(RMTC)



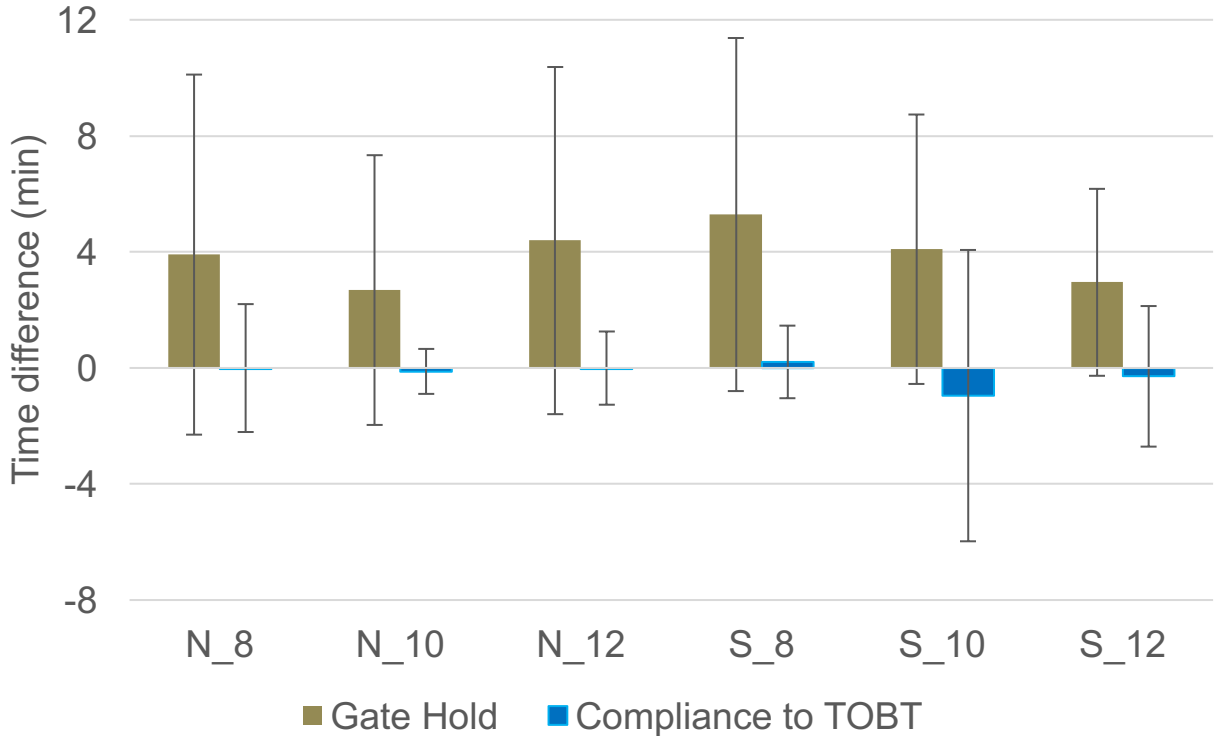
Ramp Traffic Console





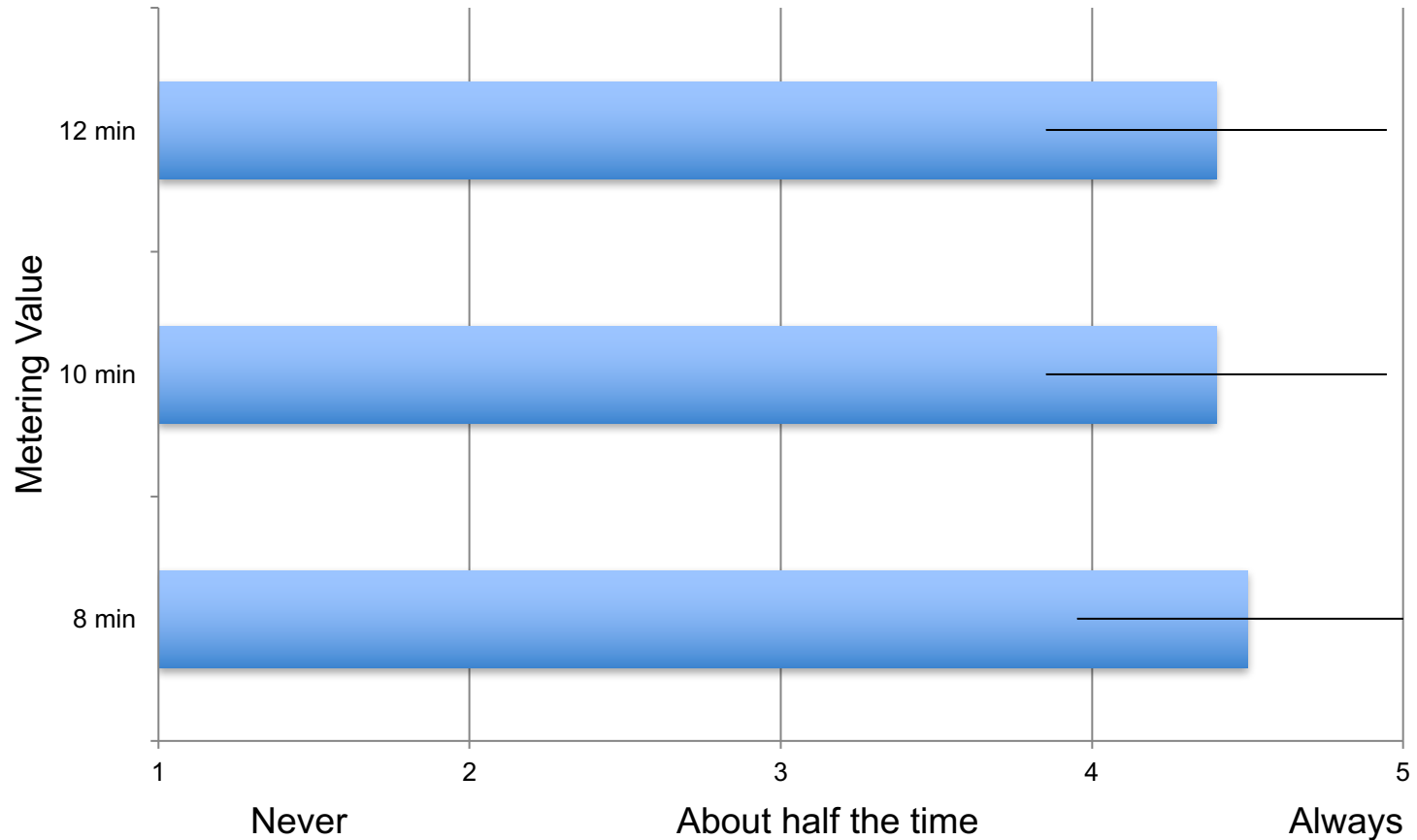
- Gate Hold Time
- Acceptability of Gate Hold Times
- Taxi Out Time
- Taxi In Time
- Queue in Airport Movement Area
- Run Durations
- Workload
- Situational Awareness
- Acceptability of departure queue
- Acceptability of departure demand

Gate Hold Time



- South Flow Gate holds decrease as metering value increases
- North Flow is possibly impacted by short run duration
- Compliance to gate hold times is within 1 min

Acceptability of Gate Hold Times

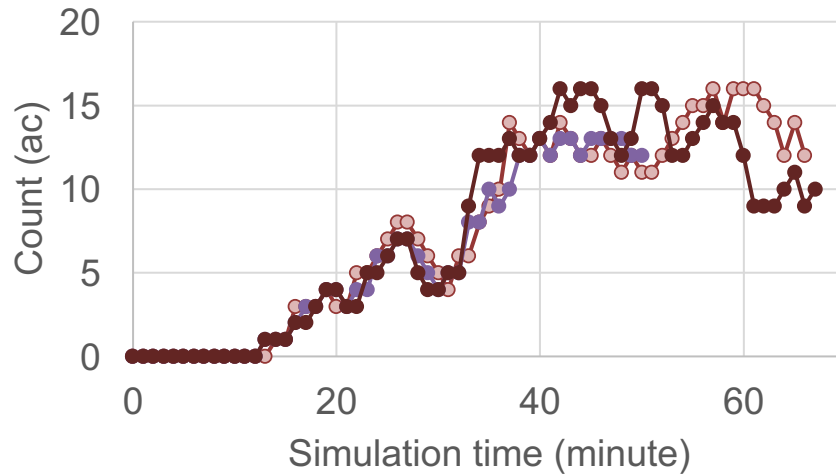


Gate hold times were reported as “just right” by the participants

Queue in Movement Area



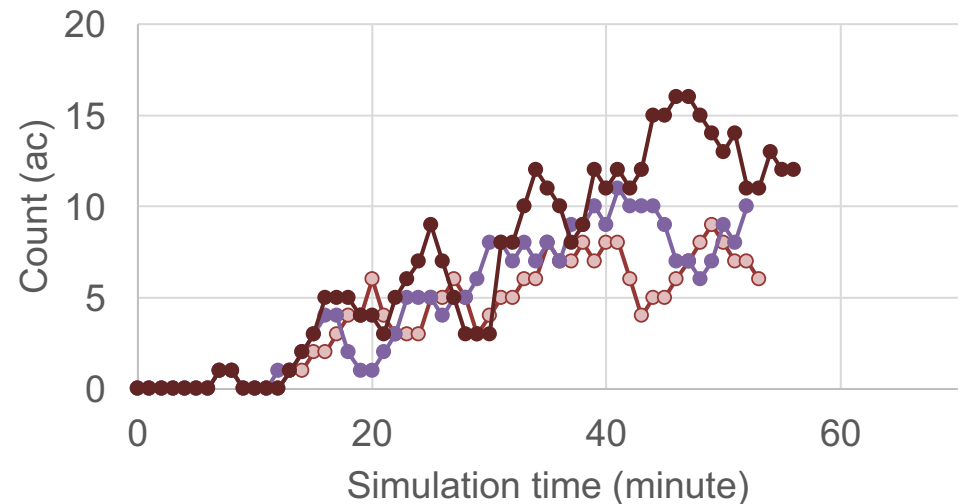
North Flow Queue in Movement Area



—○— N_8 —●— N_10 —●— N_12

- South Flow responds to different Metering values
- North Flow is not as responsive

South Flow Queue in Movement Area



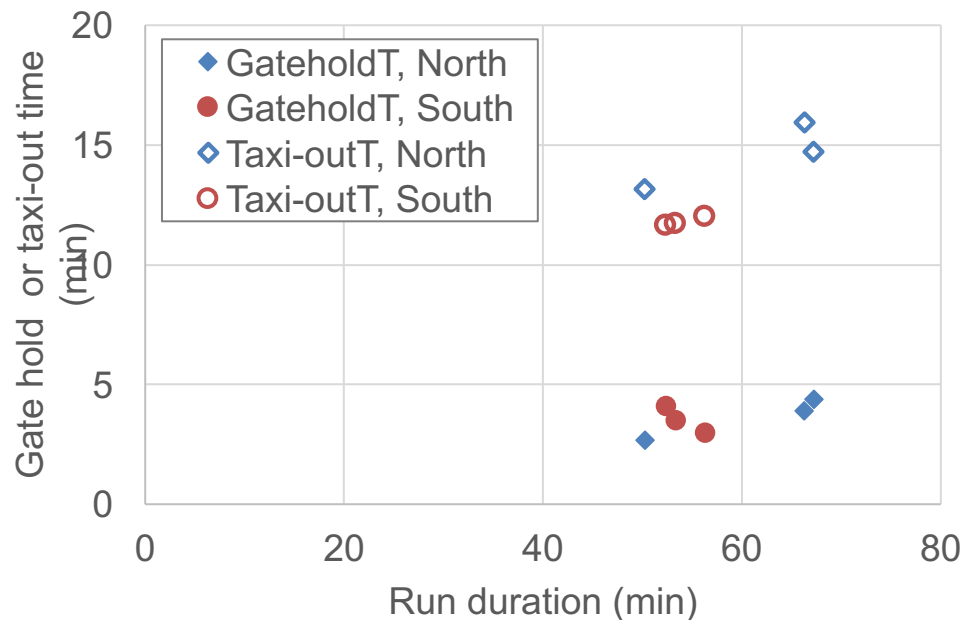
—○— S_8 —●— S_10 —●— S_12

Run Duration

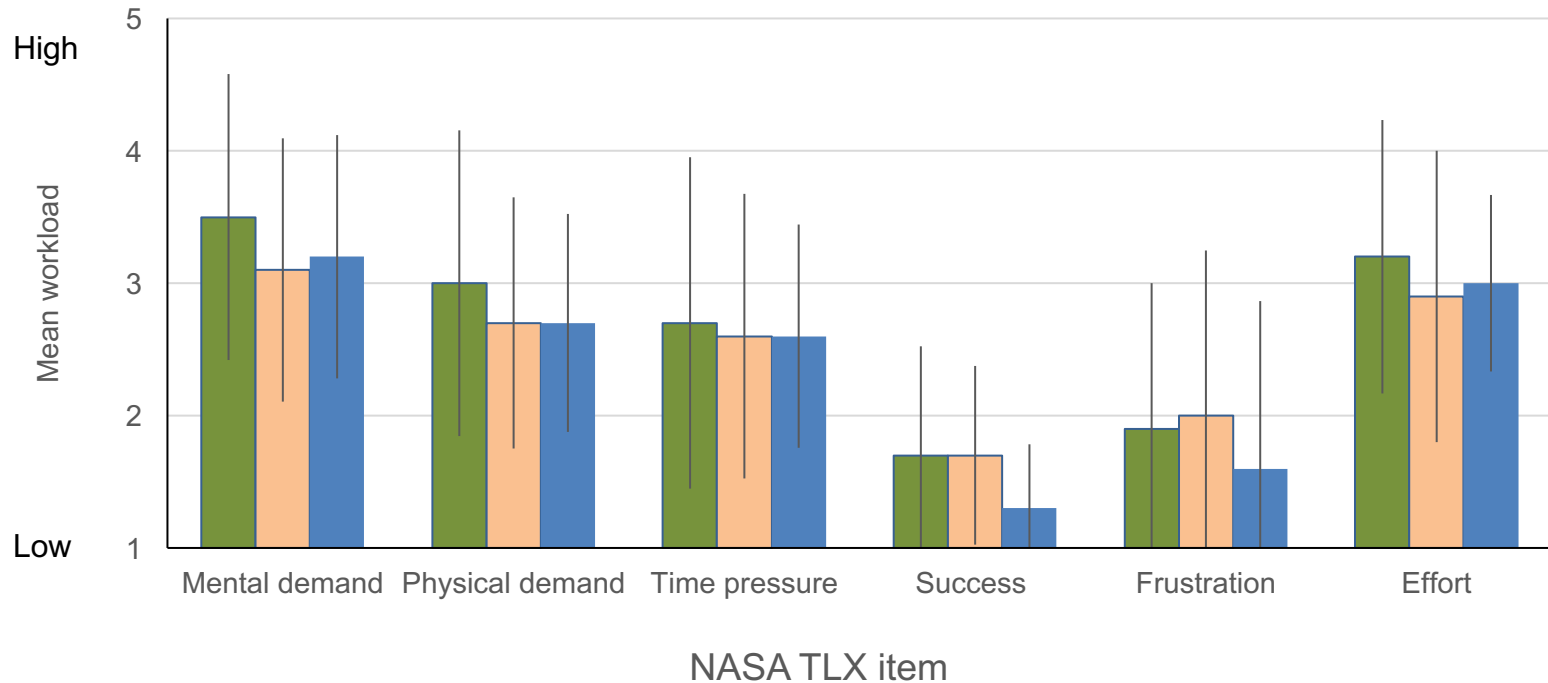


Run name	Runway Configuration	Metering value (min)	Run duration (min)	Departure number (OFF)	Arrival number (IN)
N_8	North flow	8	66.3	44	38
N_10		10	50.2	27	26
N_12		12	67.2	54	50
S_8	Sou	8	53.4	42	28
S_10					
S_12					

Gate Hold and Taxi Time increases with increase in run duration more so in North Flow than South Flow



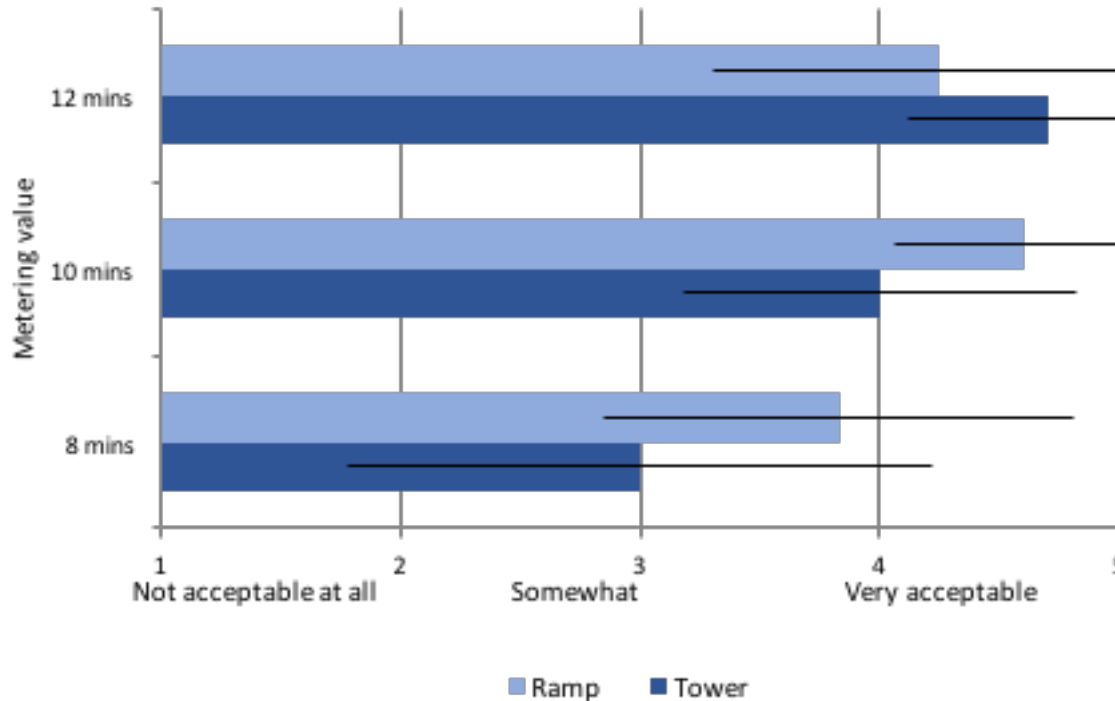
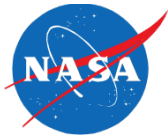
Workload – Modified Task Load Index



Metering Value ■ 8 min. ■ 10 min. ■ 12 min.

Workload was not significantly impacted by changes in the metering value

Acceptability of Departure Demand



The departure demand was reported as acceptable by both Ramp and ATC-T for metering value of 12

Summary



- Metering value affects Gate Hold Time and Queue Size as expected
- Gate Hold Times were reported as "just right"
- Metering value of 12 reported as not drying up the runway or seen as creating long queues
- Metering value of 12 planned to be used as the nominal value for metering tool when deployed in the field



Thanks for your attention!

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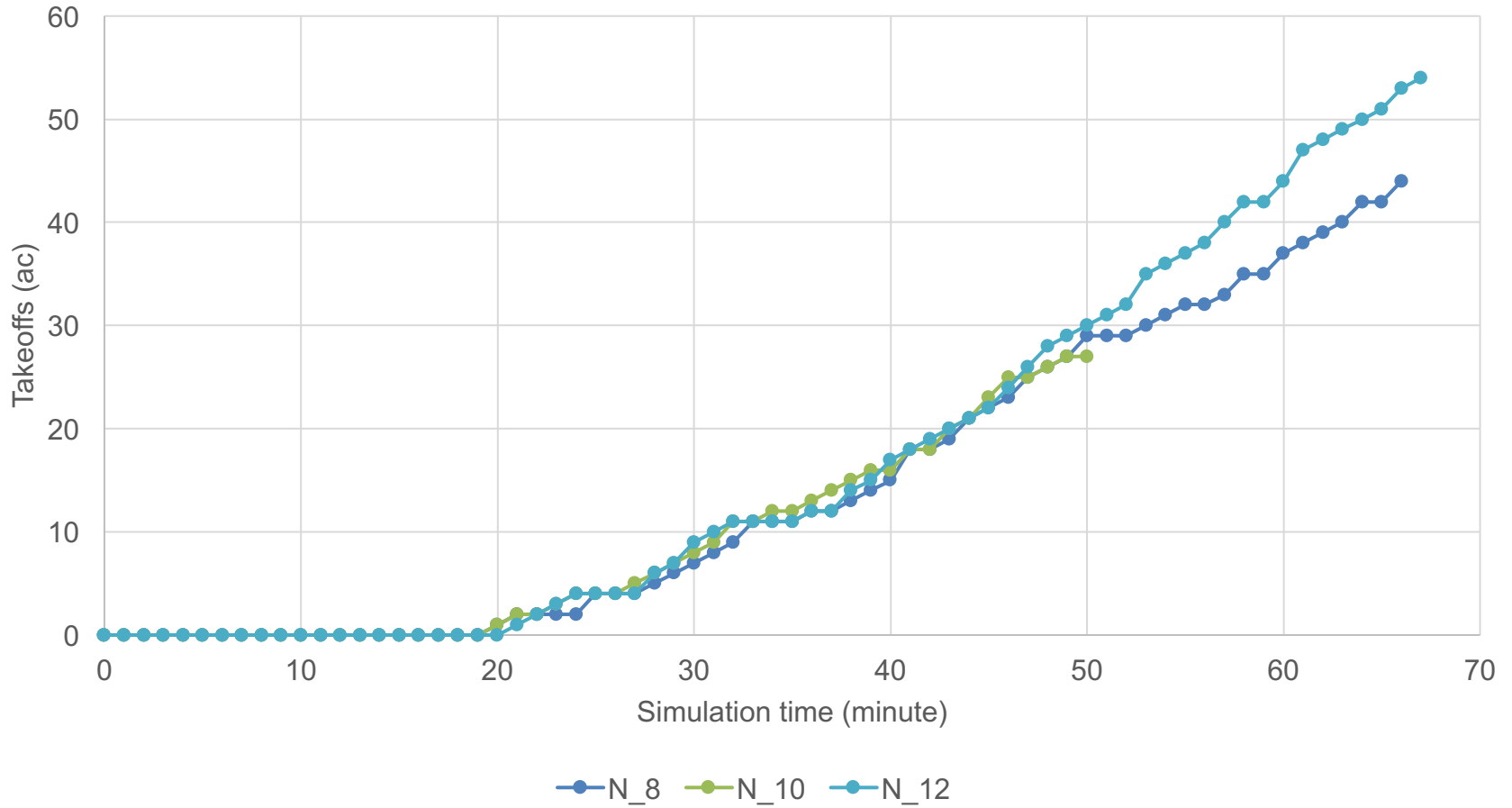
Backup slides



Throughput in North



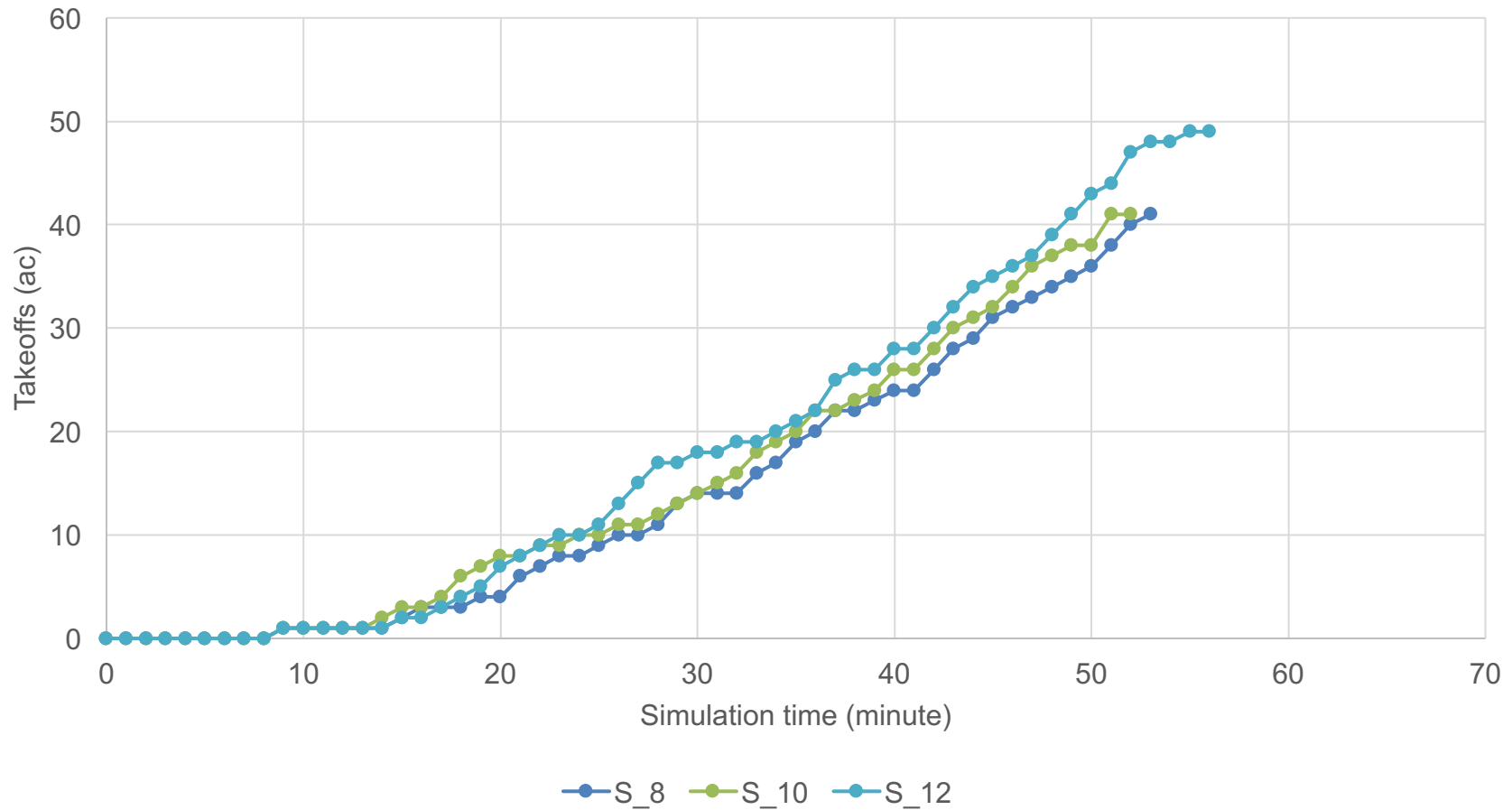
Accumulated takeoffs - North flow



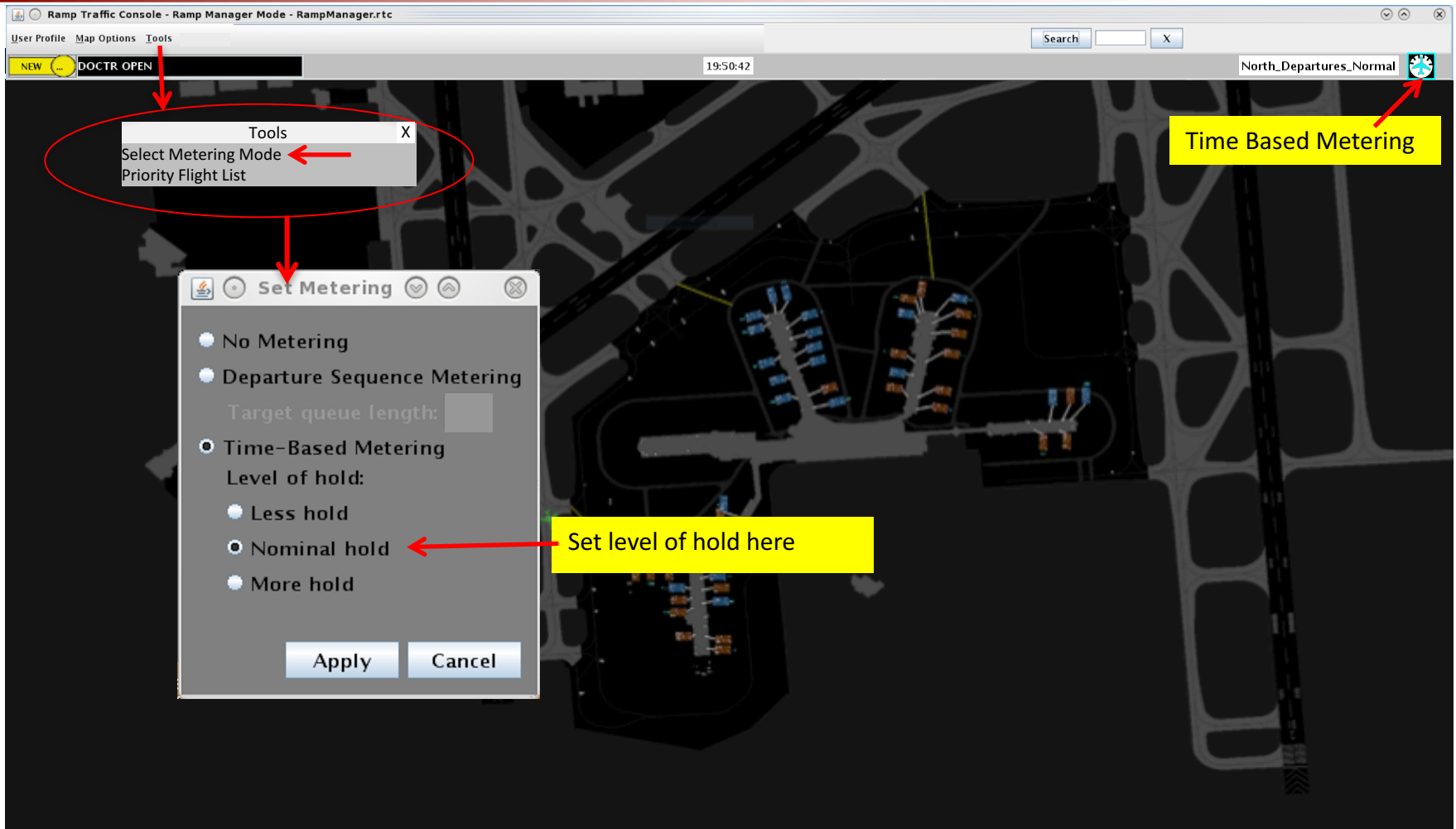
Throughput in South



Accumulated takeoffs - South flow



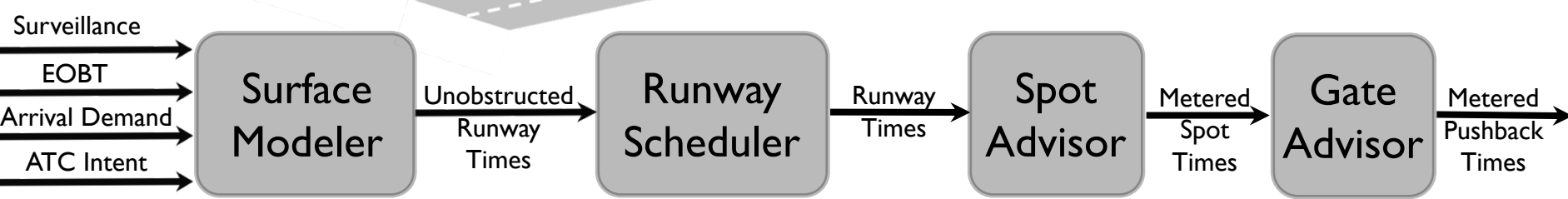
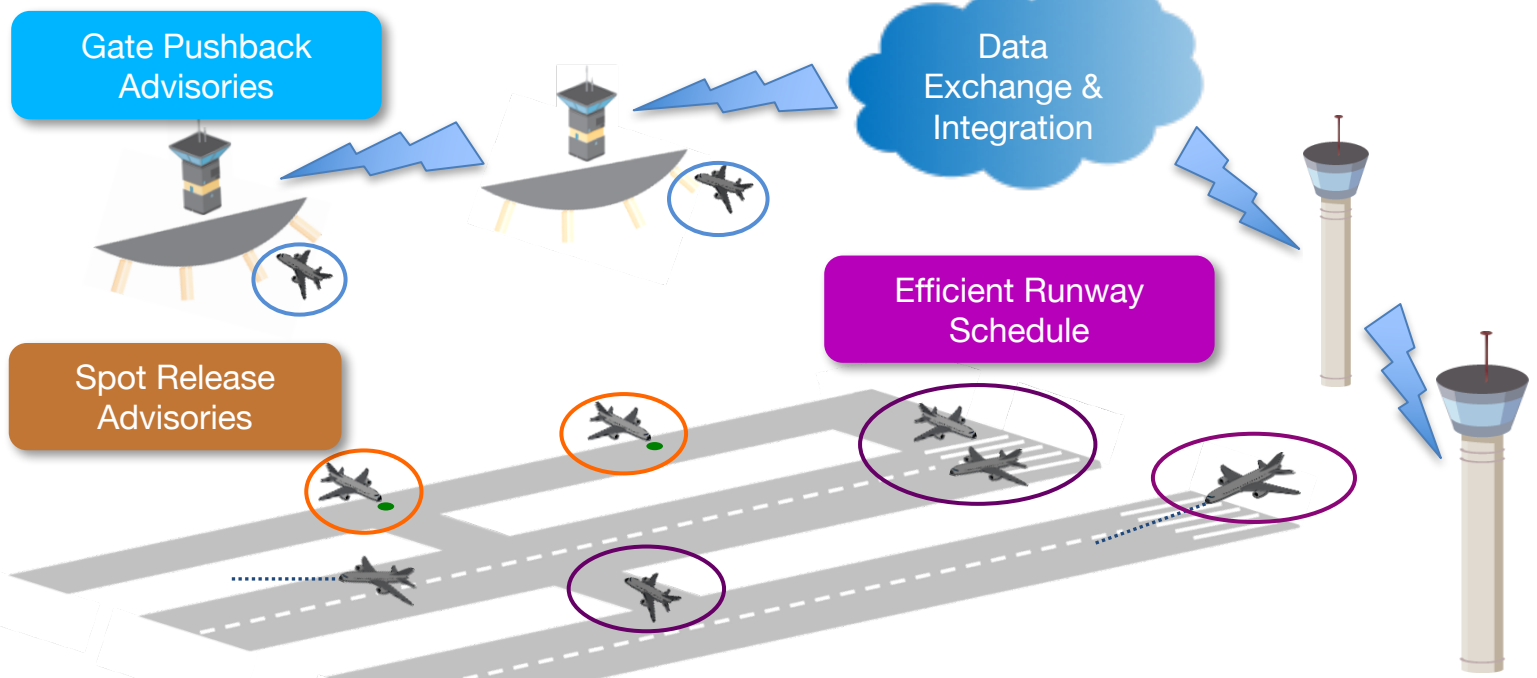
Setting Metering Value



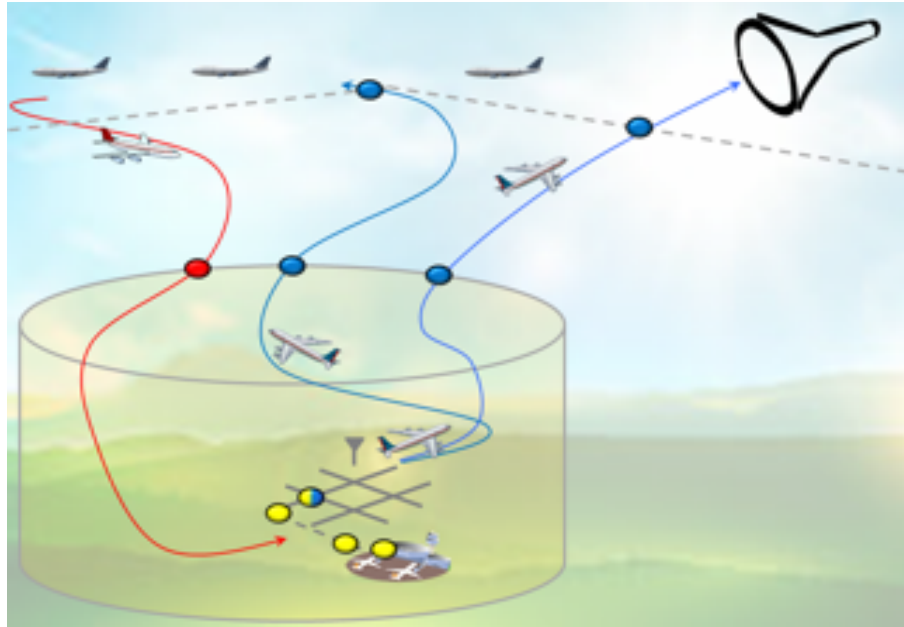
Level of Holds is based on Metering Value and is a balance between gate holds and runway queue size

Tactical Surface Metering Concept

- Estimates capacity of current and future runway resources
- Builds an efficient runway schedule based on readiness, EOBT and RBS
- Calculates spot advisories that support the metered runway schedule
- Provides push back advisories from gates that support the spot advisories



ATD-2's Metering Tool



Data Exchange & Integration

- Integrated Arrival/Departure/Surface (IADS)
- Onramp to the overhead stream
- New data elements shared between FAA & Industry
- Real-time metrics for planning and awareness

Surface modeling, scheduling & metering

- Surface modeling based on heuristics and trajectory based model of airport operations
- Use of Earliest Off Block Times (EOBT) for the purpose of Scheduling
- **Surface Metering** based on demand and capacity imbalances, tactical in nature initially

ATD-2 Users

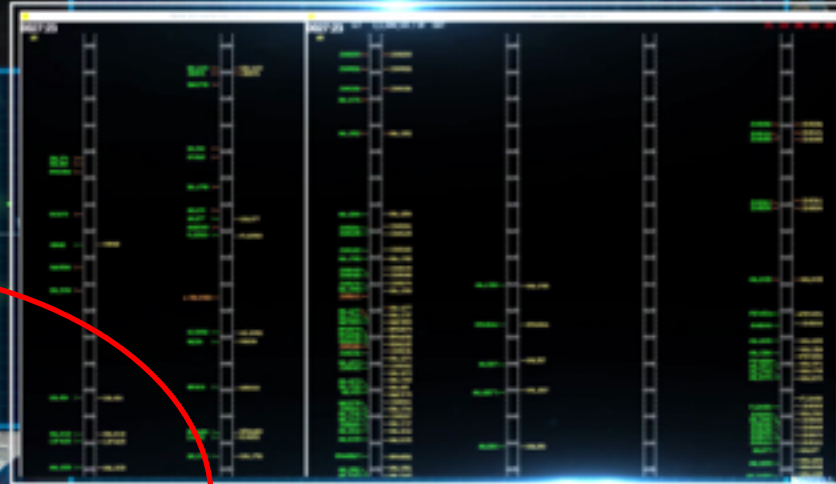


TOWER



TERMINAL

RAMP



ATD-2 SCHEDULERS

CENTER



EOBT Groups Metering Tool



Less Lower

Group	Definition
Uncertain	Flights with poor quality EOBT OR EOBT – current time > 10 min
Planning	Flights within 10 min of EOBT (i.e., EOBT – current time <= 10 min)
Ready	Flights that have called in ready for pushback
Out	Flights that are in pushback state
Taxi	Flights that are cleared for taxi
Queue	Flights waiting in the runway queue

More Higher

Predictability (downward arrow)

Order of Consideration (downward arrow)