Initial Data Analysis Results for ATD-2 ISAS HITL Simulation

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ATD-2 ISAS HITL Simulation

• 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
Tactical Surface Metering Tool

- 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

\[
TOBT = \max (EOBT, \ TTOT - X \times \text{taxi time} - Y)
\]

Note) TOBT: Target Off-Block Time, EOBT: Earliest Off-Block Time, TTOT: Target Take-Off Time
HITL Simulation Runs

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

<table>
<thead>
<tr>
<th>Run Name</th>
<th>Runway Configuration</th>
<th>Metering Value (min)</th>
<th>MIT Restriction</th>
<th>Duration (sec)</th>
<th>Dep No (OFF)</th>
<th>Arr No (IN)</th>
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Performance Metrics

• 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

<table>
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<th>N_10</th>
<th>N_12x</th>
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Gate Hold Time
• 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
Taxi-Out Time by Runway

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

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<th>50</th>
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| Arr No | 28 | 34 | 39 | 43 |

Taxi-In Time
Mean taxi-in times by runway

- Affected by other factors such as run duration, runway changes, and interaction with departures

Taxi-In Time by Runway

<table>
<thead>
<tr>
<th>Arr No</th>
<th>N_6</th>
<th>N_8</th>
<th>N_10</th>
<th>N_12x</th>
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Effects of Run Durations

- Mean values of gate hold times and taxi-out times look proportional to run durations.

![Run duration vs. Gate hold time](chart1)

- Run duration vs. Gate hold time

![Run duration vs. Taxi-out time](chart2)

- Run duration vs. Taxi-out time
Runway changes from schedule to actual assignment can impact the airport performance.

### North flow

<table>
<thead>
<tr>
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<th>N_8</th>
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<td>33 -&gt; 29</td>
<td>33 -&gt; 27</td>
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<tr>
<td>36C (Westbd)</td>
<td>35 -&gt; 44</td>
<td>35 -&gt; 44</td>
<td>35 -&gt; 39</td>
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<td>36R -&gt; 36C</td>
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<td>12</td>
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### South flow

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<th>S_12x</th>
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</thead>
<tbody>
<tr>
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<td>18C (Westbd)</td>
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Accumulated takeoffs

- Similar takeoff rates, except for No MIT cases

Accumulated takeoffs - North flow

Accumulated takeoffs - South flow
Runway Throughput by Runway

Accumulated takeoffs on 36R - North flow

Accumulated takeoffs on 36C - North flow

Accumulated takeoffs on 18L - South flow

Accumulated takeoffs on 18C - South flow

Simulation time (minute)

Takeoffs (ac)

- N_6
- N_8
- N_10
- N_12x

Simulation time (minute)

Takeoffs (ac)

- S_8
- S_10
- S_12
- S_12x
Queue Size from Gate/Spot to Runway

**Surface count - North flow**

**Surface count - South flow**

**AMA count - North flow**

**AMA count - South flow**

Simulation time (minute)

Count (ac)
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

Simulation time (minute)

Count (ac)

N_6  N_8  N_10  N_12x

S_8  S_10  S_12  S_12x
Time Spent in Departure Queue

• 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

<table>
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<tr>
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(sec/ac) North flow

(sec/ac) South flow
• 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.
• 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)
Summary

• 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.