Initial Data Analysis Results for ATD-2 ISAS HITL Simulation

Hanbong Lee

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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

Call Ready | TOBT | TTOT
---|---|---
1400 | 1402 | 1421

- Unimpeded Taxi Time: 10 min
- Predicted Time in Queue: 11 min
- Target Time in Queue: 8 min
- Taxi Time Buffer: 10% of 10 min = 1 min
- Unimpeded Taxi Time: 10 min

TOBT = max (EOBT, TTOT – X * taxi time – Y)

X: Taxi time buffer (e.g., X=1.1)
Y: Metering buffer (e.g., Y=8min)

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>
</tr>
</thead>
<tbody>
<tr>
<td>N_6</td>
<td>North flow</td>
<td>More hold 6</td>
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<td>3536</td>
<td>35</td>
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<td>N_8</td>
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<tr>
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<td>Less hold 12</td>
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<td>54</td>
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<td>Less hold 12</td>
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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
**Taxi-Out 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

### North flow

<table>
<thead>
<tr>
<th>Dep No</th>
<th>N_6</th>
<th>N_8</th>
<th>N_10</th>
<th>N_12x</th>
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</thead>
<tbody>
<tr>
<td>Runway Change</td>
<td>9</td>
<td>9</td>
<td>4</td>
<td>12</td>
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</table>

### South flow

<table>
<thead>
<tr>
<th>Dep No</th>
<th>S_8</th>
<th>S_10</th>
<th>S_12</th>
<th>S_12x</th>
</tr>
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<tbody>
<tr>
<td>Runway Change</td>
<td>8</td>
<td>7</td>
<td>8</td>
<td>11</td>
</tr>
</tbody>
</table>
• Mean taxi-out times by runway
  – Longer taxi distance for Westbound flights

![Graph showing taxi-out times by runway](image)
• 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.
Taxi-In Time by Runway

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

### North flow

<table>
<thead>
<tr>
<th>Arr No</th>
<th>7</th>
<th>20</th>
<th>7</th>
<th>16</th>
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<tr>
<td>Sec/ac</td>
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### South flow

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<th>14</th>
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</thead>
<tbody>
<tr>
<td>Sec/ac</td>
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</tr>
</tbody>
</table>

![North Flow Chart](chart_north.png)

![South Flow Chart](chart_south.png)
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.

<table>
<thead>
<tr>
<th>North flow</th>
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<th>N_8</th>
<th>N_10</th>
<th>N_12x</th>
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</thead>
<tbody>
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<td>33 -&gt; 24</td>
<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>
<td>35 -&gt; 41</td>
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<tr>
<td>36R -&gt; 36C</td>
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<td>9</td>
<td>4</td>
<td>9</td>
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<td>0</td>
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<tr>
<td>Total</td>
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<td>9</td>
<td>4</td>
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<table>
<thead>
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<th>South flow</th>
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<th>S_10</th>
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<th>S_12x</th>
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<tbody>
<tr>
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<td>41 -&gt; 36</td>
<td>41 -&gt; 39</td>
<td>41 -&gt; 34</td>
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<tr>
<td>18C (Westbd)</td>
<td>22 -&gt; 24</td>
<td>22 -&gt; 27</td>
<td>22 -&gt; 24</td>
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<tr>
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<td>2</td>
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<tr>
<td>Total</td>
<td>8</td>
<td>7</td>
<td>8</td>
<td>11</td>
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</table>
• Accumulated takeoffs
  – Similar takeoff rates, except for No MIT cases
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
Queue Size from Gate/Spot to Runway

Surface count - North flow

Simulation time (minute)

Surface count - South flow

Simulation time (minute)

AMA count - North flow

Simulation time (minute)

AMA count - South flow

Simulation time (minute)
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
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
- 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.