AN ALGORITHM FOR
TMA ENTRANCE POINT MULTIPLICITY

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The current airspace system is under growing strain as the demand for air travel increases steadily every year.

TMA s, as the conjunction of airports and air routes, have a significant impact on the throughput of airports and en route airspace.

Therefore, reorganization of TMA s is crucial to accommodate the increasing number of flights.
AIMS OF THE STUDY

• To determine points of congestion in a sample TMA
• To develop an algorithm for duplicate these points
• To reduce the total delay at these points
MODEL DESCRIPTION - ISTANBUL TMA

- ANADOLU UNIVERSITY
  - FACULTY of AERONAUTICS and ASTRONAUTICS
  - AIR TRAFFIC CONTROL DEPARTMENT

- NEW AIRPORT
- CORLU AIRPORT
- SABIHA GOKCEN AIRPORT
- ATATURK AIRPORT
## Flight number of Istanbul TMA airports in 2011

<table>
<thead>
<tr>
<th></th>
<th>Number of flight</th>
<th>Percent %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ataturk Airport</td>
<td>325,209</td>
<td>69</td>
</tr>
<tr>
<td>Sabiha Gokcen Airport</td>
<td>121,407</td>
<td>26</td>
</tr>
<tr>
<td>Tekirdag Corlu Airport</td>
<td>23,207</td>
<td>5</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>469,823</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>
MODEL DESCRIPTION - ISTANBUL TMA
Assumptions

- Arrival traffic in the Istanbul TMA,
  - Atatürk arrival traffic to runway 05,
  - Sabiha Gökçen arrival traffic to runway 06,
  - Corlu arrival traffic to runway 05 is analyzed.
- Departure traffic will be covered in future studies.
- Within the model, differences among aircraft performance are ignored. To prevent performance differences, all the aircraft are chosen as B738 in Medium category.
- Separation between aircraft,
  - within the en-route control airspace is determined as 10NM
  - in terminal control airspace is determined as 3NM
  according to ICAO Separation minima and Turkish AIP.
• SIMMOD, discrete event simulation tool, is used for delay analyses.

• SIMMOD provides a fast time simulation analysis and it uses links and nodes to describe airspace and airports.

• Airports, airways and fixes information are received Turkish AIP.
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ALTERNATIVE SCENARIO

[Diagram of air traffic routes with multiple nodes and connections, highlighting SBH with arrows.]
ALTERNATIVE SCENARIO

CURRENT SCENARIO

ALTERNATIVE SCENARIO

NUMBER OF AIRCRAFT PER ENTRY POINT

DELAY (MIN)
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AIR TRAFFIC CONTROL DEPARTMENT

CRITICAL FIXES OF TMA
NEW ARRIVAL ROUTE OF TMA
<table>
<thead>
<tr>
<th>Entry point number</th>
<th>Flight demand each entry point</th>
<th>Aircraft number with delay</th>
<th>TMA Delay min.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>t&lt;5</td>
<td>t=5-10</td>
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<tr>
<td>11</td>
<td>8</td>
<td>59</td>
<td>23</td>
</tr>
<tr>
<td>12</td>
<td>8</td>
<td>68</td>
<td>15</td>
</tr>
<tr>
<td>13</td>
<td>7</td>
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<td>14</td>
<td>6</td>
<td>73</td>
<td>13</td>
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<td>15</td>
<td>6</td>
<td>69</td>
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<td>8</td>
</tr>
<tr>
<td>18</td>
<td>5</td>
<td>75</td>
<td>14</td>
</tr>
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</table>
• Results of this study indicate a positive impact of new entry-points and routes on total delays in the selected TMA.

• Introduction of new existing point serving for a single airport relieves congestions at the existing ones. Since the algorithm also provides alternative routes to the destination airports with minimum number of route crossings, the delays at fixes within the TMA reduces in the alternative scenarios.

• Therefore, the entry-point multiplication algorithm offers effective alternative solutions that can be used in dynamic airspace planning at peak-traffic periods.

• In the future work, the algorithm will be developed for more realistic TMA models including departure routes and aircraft performance differences.