Impact of Equipage on Air Force Mission Effectiveness

Presentation at ICCRTS
Background

- On 3 April 1996 a military version of the Boeing 737 crashed in Dubrovnik, Croatia
  - Sec. of Commerce Ronald Brown one of 35 killed
  - USAF investigation found faulty navigation equipment partly to blame
- Global Access, Navigation, and Safety (GANS) program established in 1997
  - Focal point for Air Force requirements
- Air Force policy (2001)
  “Conform to the appropriate civil communication, navigation, surveillance/air traffic management (CNS/ATM) performance standards to guarantee access to worldwide controlled airspace”.
Some key points

- CNS/ATM capability is expensive
  - Equipment costs *plus* integration costs
  - Range up to millions of dollars per aircraft

- Mobility Air Force (MAF) supports Combat Air Forces (CAF)
  - Different platforms, different philosophies, and different goals

- US Air Force is a user of civilian-managed airspace
Key Assumptions

- Civilian Air Traffic will continue to increase
  - In line with Eurocontrol forecasts
- Political considerations will drive stricter regulatory environment
  - Basing limitations
  - Denial to airspace access; waiver process delays
- Flexible Use of Airspace (FUA) and European Single Sky initiatives will further constrain military
  - Limited availability of special use airspace (SUAs)
  - ALTRVs (reserved air corridors) will be hard to obtain
  - Missions will be required to fly within civil traffic
  - Longer Military routes to mission operations areas
Analysis Hypothesis

- Premise: Aircraft equipped with specific CNS capabilities gain from civil authorities
  - More optimal routing; more efficient use of civil airspace
  - Reduced airspace denials
  - More flexibility resulting from less setup time and planning

- Premise: Uncertainties regarding use of civil airspace drive workarounds and contingency planning
  - Pilots plan for worst case
  - Result is inefficient mission plans and in-transit routing

- Hypothesis: Aircraft with better CNS capability gain…
  - Reduced variability in arrival times
  - Improved ops tempo
  - Better resource utilization
  - Improved dynamic task execution
Analysis Process

1. Falconview, standard Mission Planning tool, generated air routes
   - Accomplished at detailed level; operationally realistic
   - First cut at tanker/fuel utilization

2. Military routes overlaid on civilian traffic in CAPER
   - Congestion impact assessed at sector level by altitude
   - Weather based on U.S. experience
   - Refueling variance based on AMC inputs/experience

3. CAPER output passed through Monte Carlo process
   - Ran five hundred missions per day; 100 trials per aircraft;
   - Partitioned results into four periods per day
   - Variance resulting from weather, congestion, and refueling
   - Ops tempo metrics for individual aircraft and tanker utilization

4. Individual aircraft ETAs and variance aggregated to assess strike package formation
   - Failures to form strike packages can be varied to reflect experience

5. Number of failures used to generate AOC impacts in MSim model
   - Failures to form strike packages treated as critical event within AOC
Hypothetical Mission

Objective:
Air strike on a military airport in Southwest Asia

Scenario 1:
- Fighters based in UK
- Current and future CNS/ATM capabilities

Scenario 2:
- Fighters based in Eastern Europe
- Current and future CNS/ATM capabilities
- Include a fighter drag case

Notional Strike Package:
- B-52 (1)
- F-15D (4)
- F-15C (2)
- F-16C (4)
- E-3
- E-8
- RC-135
- KC-10

CNS Capabilities Considered:
- 8.33 kHz Voice Communications
- FM Immunity
Steps of Analysis and Tools used in CNS/ATM Impact Study

1. FalconView
   - Capable and Non-Capable Military Routes
2. CAPER
3. 1st Monte Carlo
   - Aircraft Flight Time for Each Route
4. 2nd Monte Carlo
5. MSIM
   - ETA Distributions for Each Route
   - Missed Packages
   - Resource Utilization (People)
   - Average Time to Process a Critical Event
   - Sortie Rate
   - Resource Utilization (Fuel, Tankers)

- Scenarios Based on CAF/MAF Processes, CNS Roadmap, and Eurocontrol Regulations
- ATO
- Time on Target (From ATO)
- AOC Model

Output from Tool Used as Input
Input to Tool
Tool Output
Fighter and Bomber Routes
UK-Based Scenario

- F15Cs, F15Ds
- F16s and Equipped B52
- Unequipped B52
Fighter and Bomber Routes
European-Based Scenario

- Unequipped B52
- Equipped B52
- F16s
- F15Ds
- F15Cs
Civilian Air Traffic Visualization
Structured Routes
Model Reroute
Execute Reroute
Animation

See Movie Here
Bases in UK, F-15C, Time Period 4

Not Capable: 435 minutes, 134 spread  CNS Capable: 363 minutes, 107 spread

CNS Capable: 377 minutes 133 spread

• 74 minutes faster and
• 12 minutes less variability

The CNS capable case arrives faster, with better predictability.
# Package Formation

(4 Aircraft, Time Period 4, 2010)

Note: sortie rate shows relative differences not absolute values

## Base in Hungary (F-15C)

<table>
<thead>
<tr>
<th>Not Capable</th>
<th>Capable</th>
<th>Not Capable Drag</th>
<th>Sortie Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>504 ±28 minutes</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>470 ±26</td>
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## Base in Italy (F-16C)

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<td>664 ±36</td>
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<td>609 ±35</td>
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## Base in Macedonia (F-15D)

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<tbody>
<tr>
<td></td>
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<td>337 ±43</td>
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<td>316 ±42</td>
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## Base in the UK (F-15C)

<table>
<thead>
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<th>Not Capable Drag</th>
<th>Sortie Rate</th>
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<tbody>
<tr>
<td></td>
<td></td>
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<td>954 ±61</td>
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<td></td>
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*In Transit, Waiting at Marshaling Point, Completing Attack Phase, Return*

<table>
<thead>
<tr>
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<th>8%</th>
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<th>15%</th>
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<tbody>
<tr>
<td></td>
<td>2.9</td>
<td>3.1</td>
<td>3.3</td>
<td>1.7</td>
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<tr>
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<td>3.1</td>
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<tr>
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<td>2.4</td>
<td>2.8</td>
<td>4.3</td>
<td>4.5</td>
</tr>
</tbody>
</table>

8.33 Area

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*In Transit, Waiting at Marshaling Point, Completing Attack Phase, Return*
Effect of Packages Missed on Critical Event Response Time

Number of People Added to Handle AOC Workload

Graph: Average Additional Response Time for Critical Events (hours) vs. Number of ATO Packages Missed

- Y-axis: Average Additional Response Time for Critical Events (hours)
- X-axis: Number of ATO Packages Missed

The graph shows a positive correlation between the number of ATO packages missed and the average additional response time for critical events.
For Both 2010 and 2015, ~300,000 lbs more fuel is used, equivalent to 5 more Tankers.

* Estimate of gross number of KC135E assumes 1500 nm mission radius and takeoff at standard sea level atmosphere on 10,000 ft dry runway.
Workarounds Produce Ripple Effects

- Significant cross-enterprise feedback between CAF, MAF, and civilian ATM

- CAF workarounds produce wide-ranging ripple effects:
  1. Tanker Drag
     $\quad$ For CAF perceived to work well BUT for MAF inefficient use of tankers
  2. Leave Earlier
     $\quad$ Greater assurance of on-time arrival, BUT, sortie rates decrease, limiting flexibility. ETA variance unchanged, loitering continues at marshalling point wasting fuel.
  3. Plan to avoid regulated airspace
     $\quad$ BUT flight time, fuel consumption, crew wear and tanker usage all go up. Sortie rates decrease, reduced flexibility.
  4. Special Use Airspace (SUAs), Altitude Reservations (ALTREVs)
     $\quad$ Can work well BUT bilateral negotiations required; potential economic impacts; no guarantees, future availability in doubt
Phase 2 Summary

- Validated hypotheses: CNS capabilities analyzed provide considerable operational improvement for scenarios studied
  - Reduced ETA variability and associated waiting times
  - Reduced tanker utilization and fuel expense
  - Improved sortie rates
  - Improved capability for dynamic tasking at AOC

- Workarounds can maintain ability to get to a specific place at a specific time, at least over the short run
  - Impacts are wide-ranging and increase over time
  - Current workarounds may be unavailable in the future

- Can support enterprise decision processes
  - CNS/ATM roadmap (other capabilities, platforms, scenarios)
  - Specific issues, e.g., ability to address funding reductions of E8 CNS/ATM program
  - Flow of assets into AOR (by integration with AF ICE)