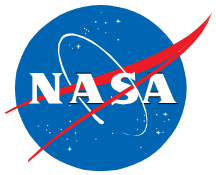

Human-in-the-Loop Evaluation of Dynamic Multi-Flight Common Route Advisories

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AIAA Aviation Technology, Integration, and Operations Conference

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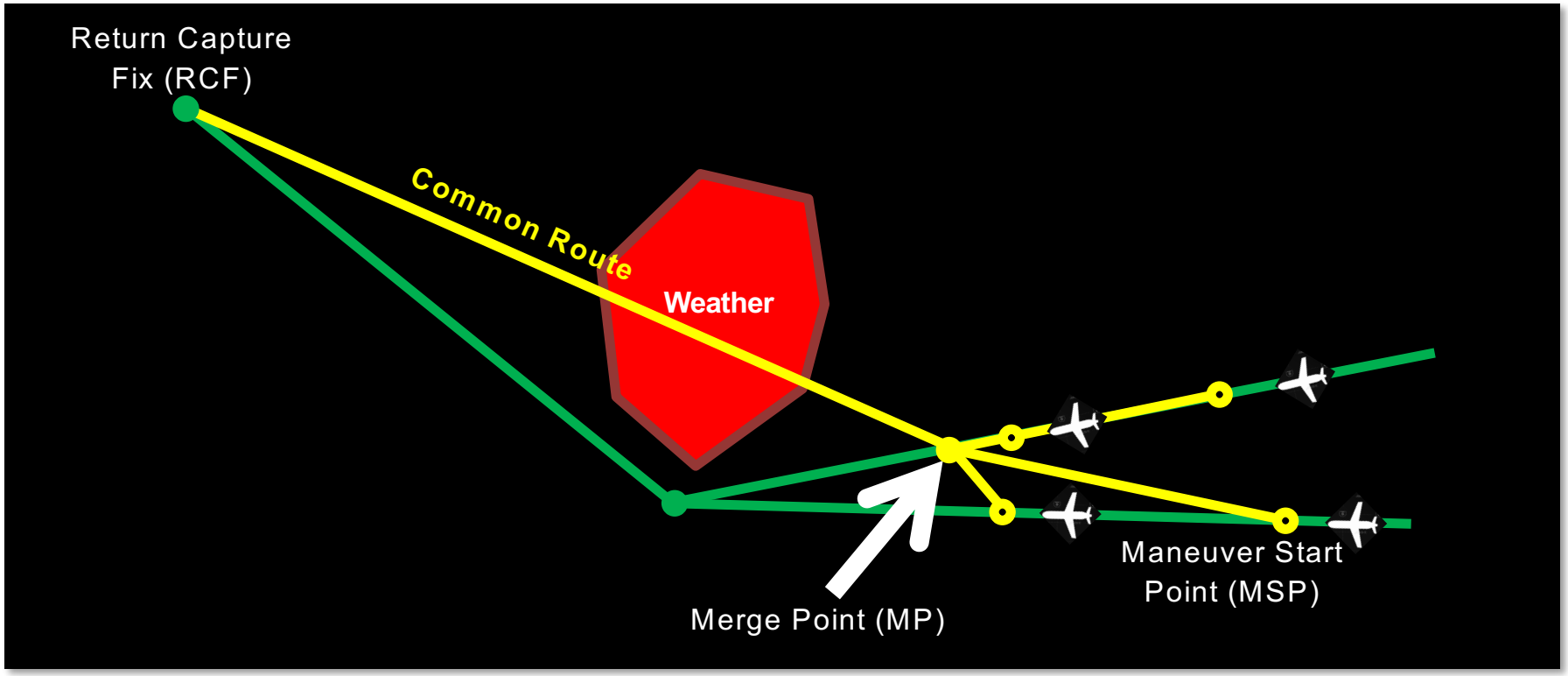
Outline

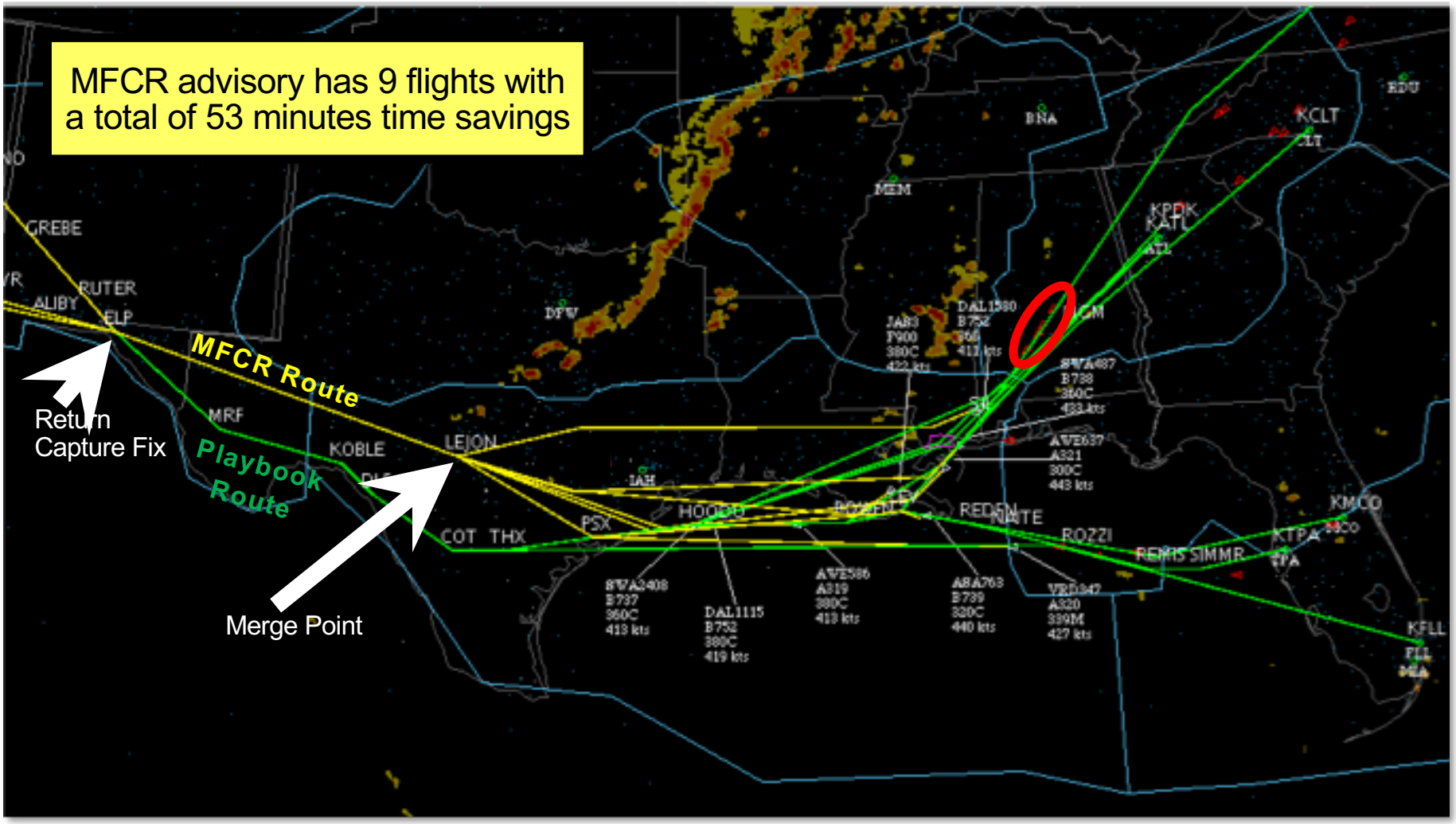
- Background on Multi-Flight Common Routes (MFCR)
- Human-in-the-Loop evaluation of MFCR
- Key Results
- Conclusions

Background

Multi-Flight Common Routes (MFCR) identifies opportunities for delay recovery by refreshing outdated routes



Example MFCR Advisory



MFCR Features

- MFCR merges multiple flights to a common route, creating a new flow for increased operational acceptability
- Each route segment is clear of weather
- Each flight has time savings of at least 3 minutes
- Total flight time savings for group is at least 10 minutes
- MFCR provides graphical functionality for review and modification prior to implementation of advisory

Human-in-the Loop Evaluation

Overview of Evaluation

- Laboratory evaluation, conducted 7 – 9 March 2017

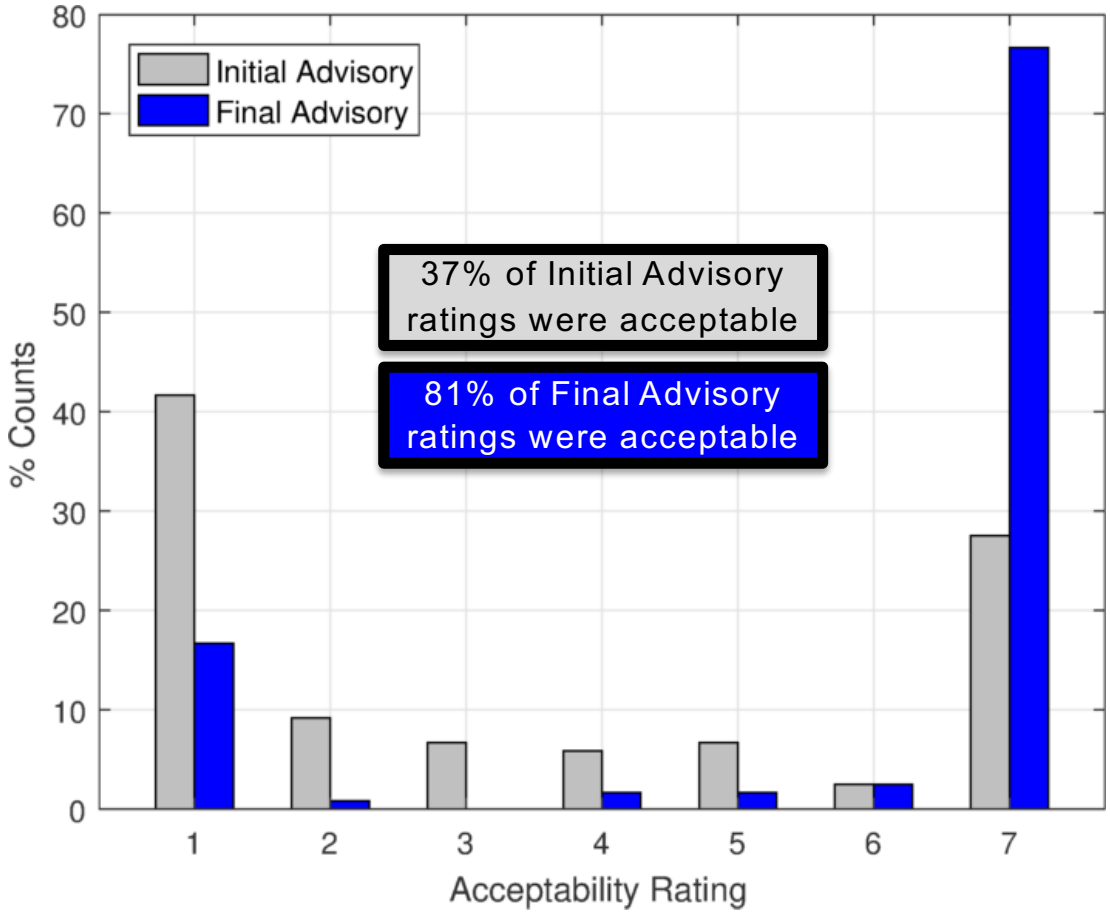
- Four subject matter experts (SMEs) evaluated scenarios in Houston Center (ZHU) airspace
  - SMEs were retired traffic managers with ZHU operations experience
  - Each SME evaluated 30 scenarios
  - Each scenario featured a single dynamic MFCR advisory

- Obtained SME feedback on:
  - Operational acceptability of MFCR re-route advisories
  - Workload and situational awareness
  - User interface
  - Viability of overall MFCR concept of operations

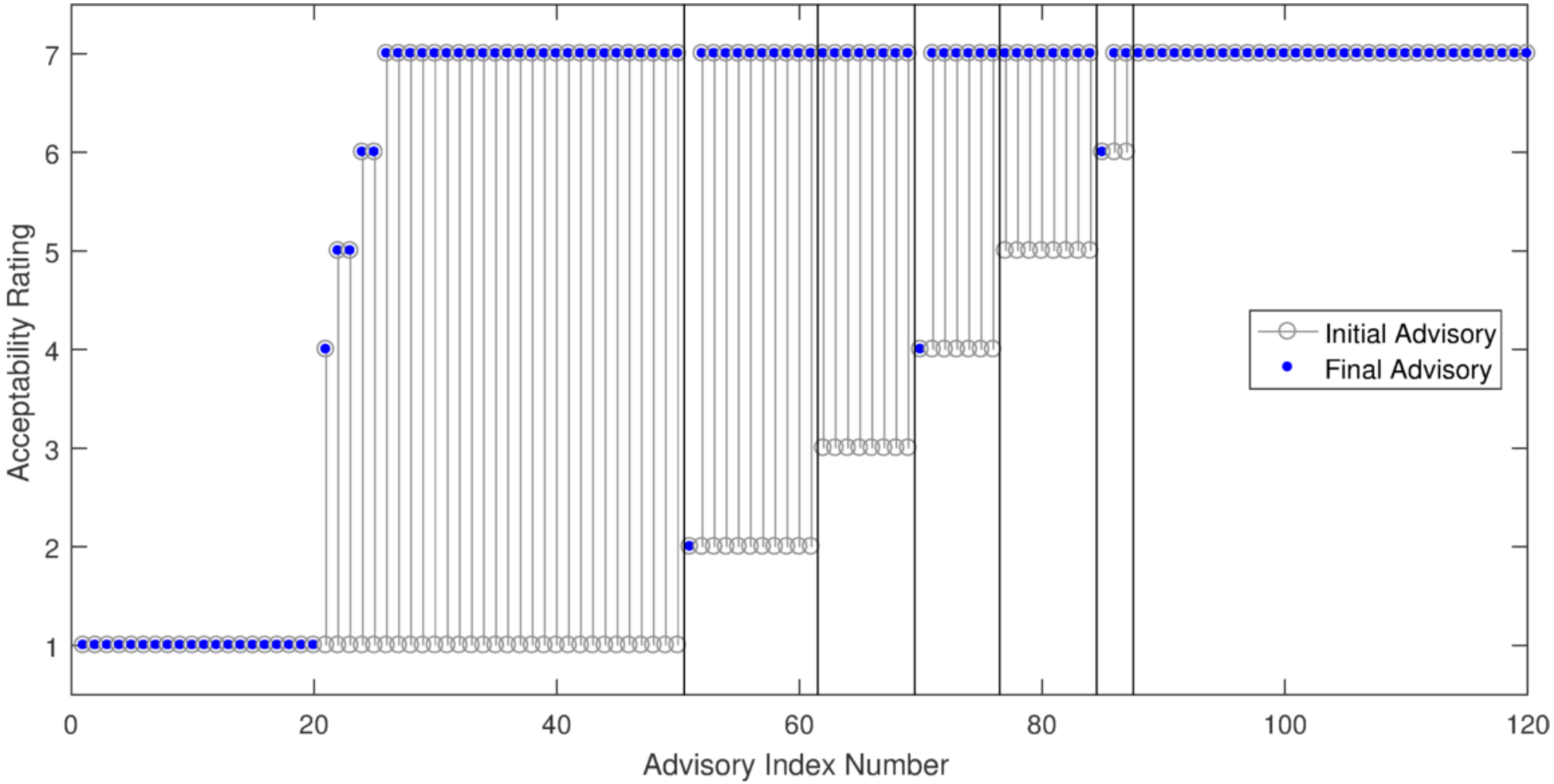
Advisory Acceptability Ratings

Statement: MFCR advisory was acceptable

1 = Disagree 4 = Neutral 7 = Agree



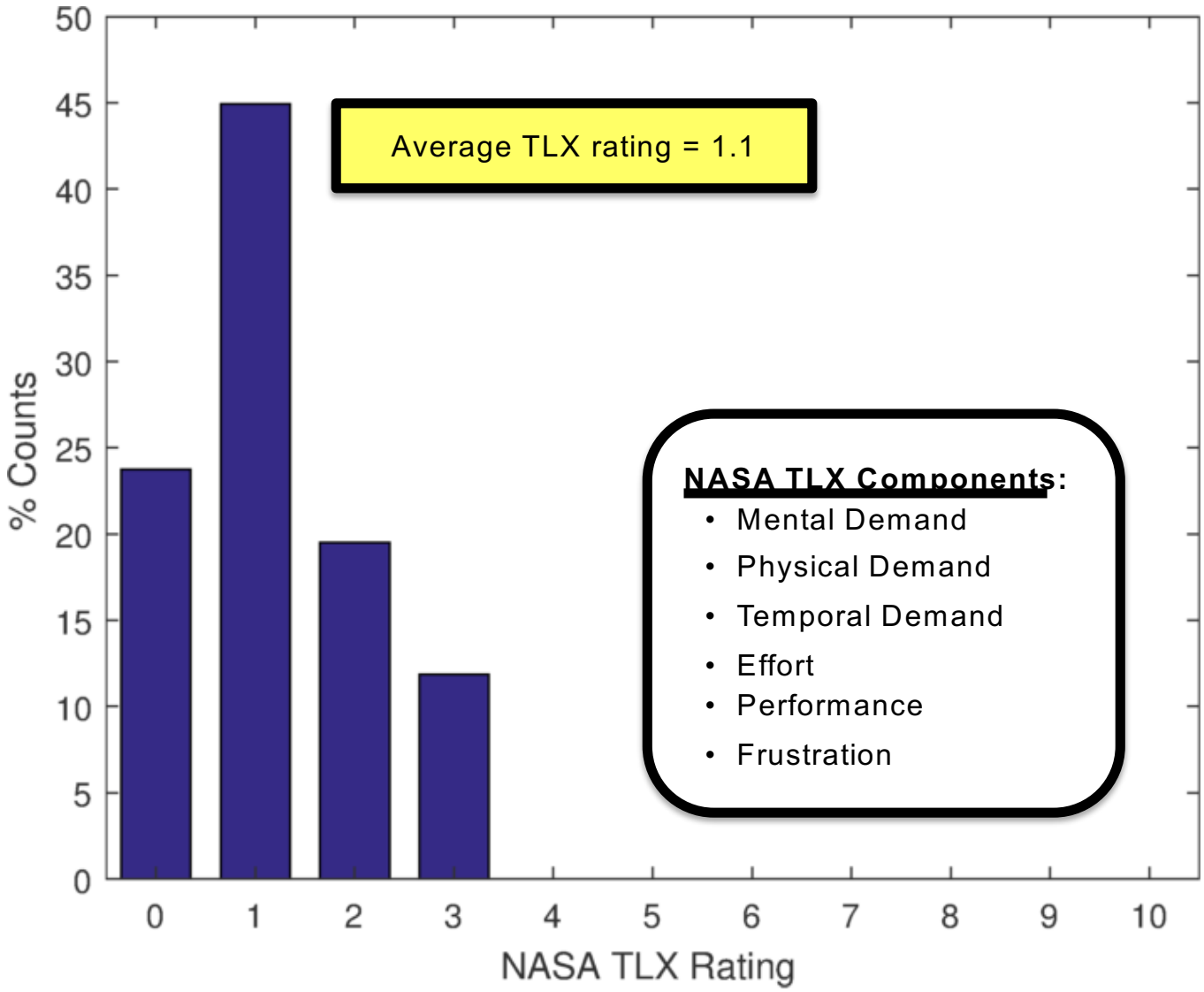
Details of Acceptability Ratings



Comments on Acceptability

- Most advisories that were initially rated as low acceptability were rated as high acceptability after SME modification
- Modifications often corrected undesirable sector traversal
  - Route runs close to sector (or Center) boundary
  - Route cuts across corner of sector(s)
  - Route crosses arrival/departure flows
  - Route crosses congested sector(s)
  - Route does not conform with standard flow patterns
- User interface provides functionality to quickly/easily make route modifications with feedback on performance measures

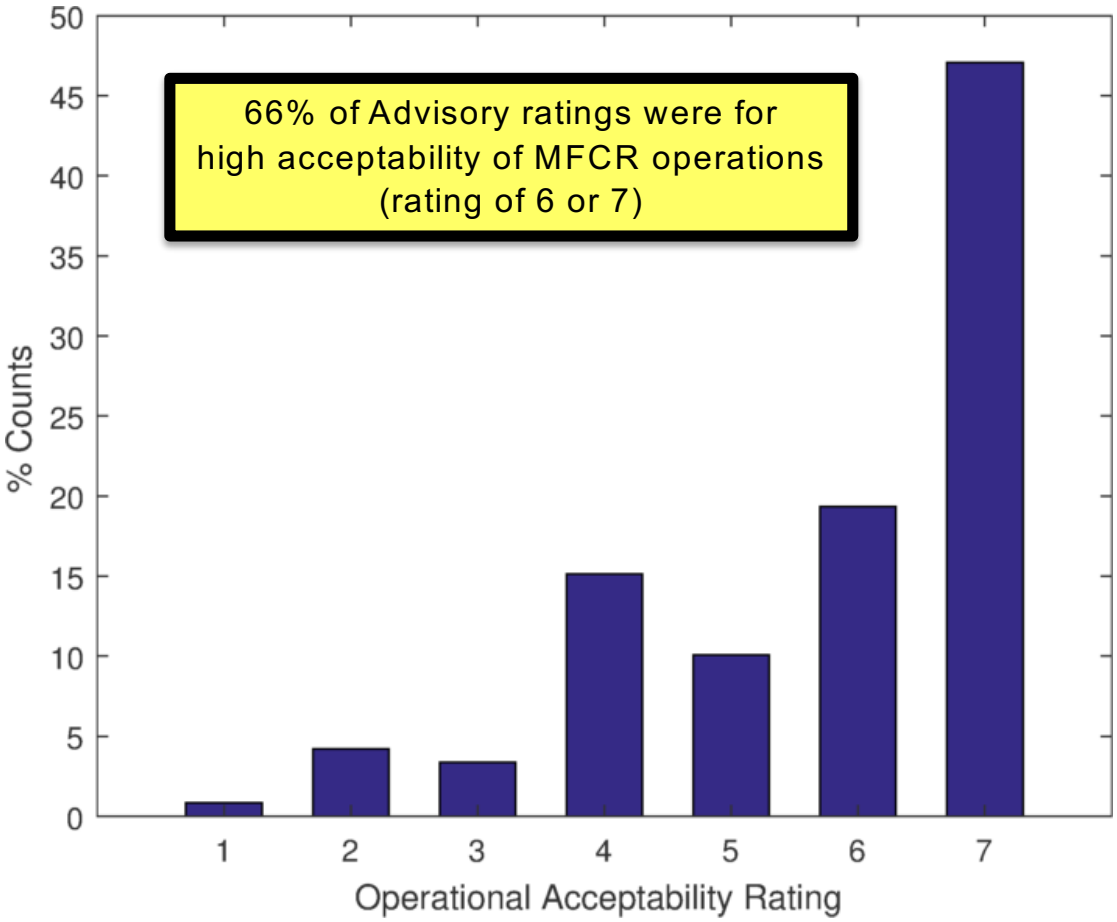
NASA Task Load Index Ratings



Acceptability of MFCR Operations

Statement: MFCR operations were acceptable

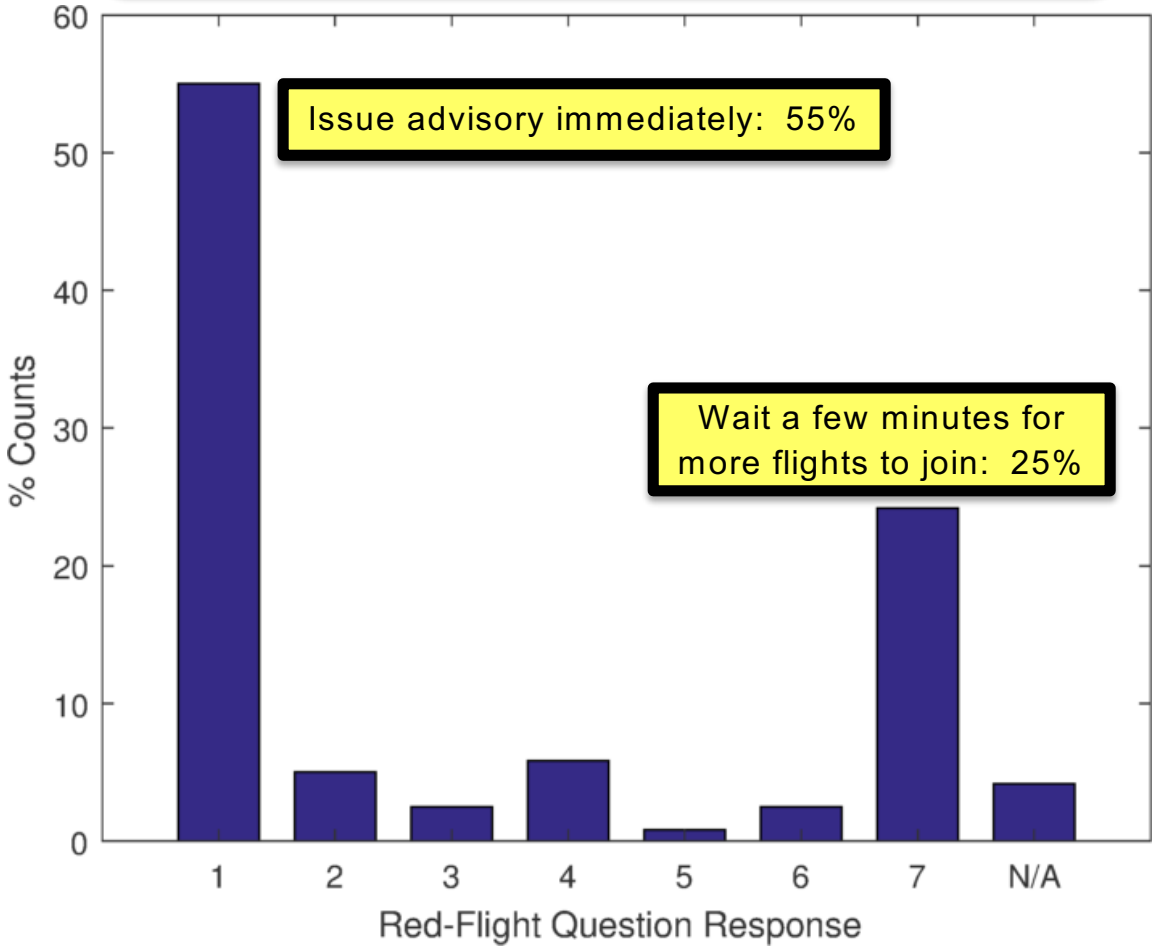
1 = Disagree 4 = Neutral 7 = Agree



Strategy for Dynamic Advisories

Statement: Wait to issue MFCR advisory

1 = Disagree 4 = Neutral 7 = Agree



Conclusions

- High acceptability of final/modified MFCR advisories: 81%
- Low workload to evaluate and modify MFCR advisories: 1.1 on a scale of [0, 10]
- Good acceptability of MFCR operations: 66%
- MFCR is a good example of human-automation teaming

Technology Transfer to FAA

- NASA completed technology transfer to FAA in Dec 2017
- Key deliverables:
  - Concept of Operations
  - Functional Requirements
  - Prototype software
- MFCR targeted for inclusion in Advanced Flight-Specific Trajectories (AFST) capability, under Collaborative Air Traffic Management Technologies (CATMT) Work Package 5

Questions?

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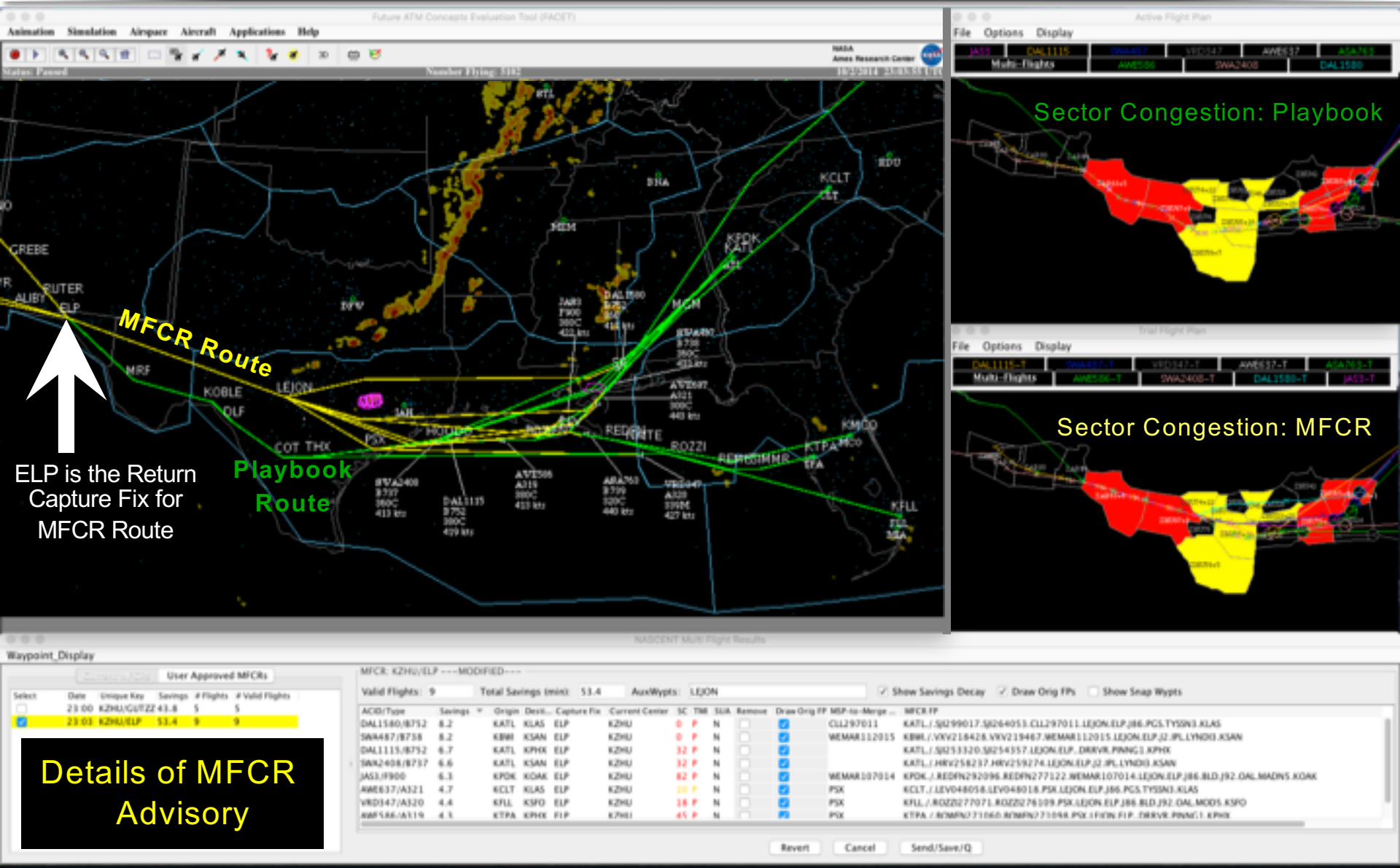
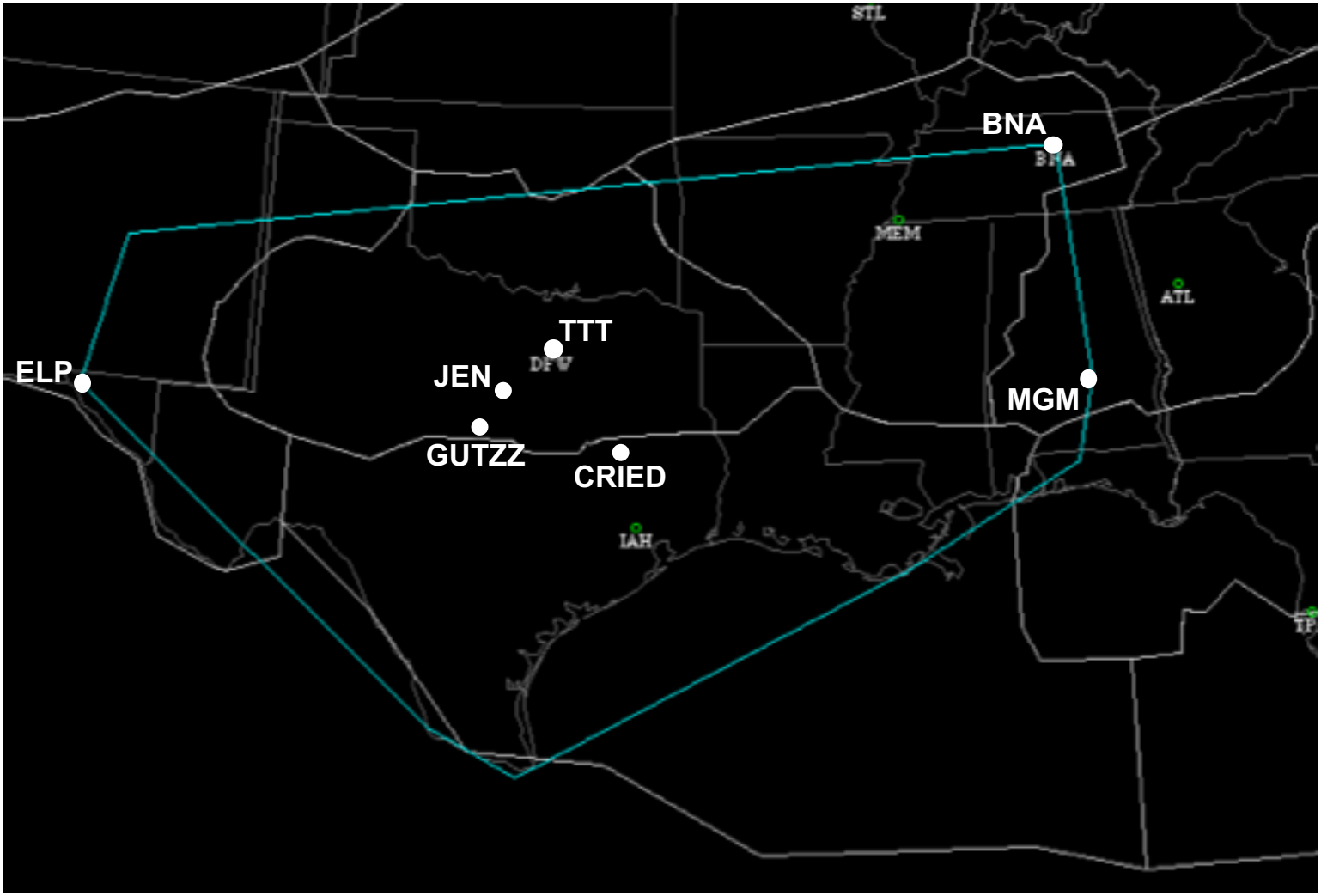
MFCR Graphical User Interface



Limit Polygon, Return Capture Fixes



MFCR Concept of Operations

- Traffic Manager evaluates/modifies the re-route advisory
  - TM coordinates (possibly using AFST interface) with:
    - TMUs of affected Centers; ATC System Command Center
    - Area Supervisors of sector controllers who "own" the affected flights
    - AOCs of affected flights
  - TM accepts advisory, possibly after further modification
- Flight plan amendments transmitted electronically to sector controllers via Airborne Re-Route (ABRR) tool
- Sector controller offers MFCR re-route option to flight crew, via voice or datalink
- Flight crew accept/decline their MFCR re-route option (may first coordinate with their Airline Operations Center)

MFCR Algorithm

- Identify individual flights whose direct route, from MSP to RCF, provides flight time savings of at least 5 minutes
  - Maneuver Start Point (MSP) is 5 minutes downstream of current position
  - Maneuver end point is current route's last waypoint inside the "limit polygon" for the Center, called the Return Capture Fix (RCF)
- Construct MFCR advisories from these individual re-routes
  - Identify groups of flights in the same Center, going to a common RCF
  - For each group, determine the best Merge Point (MP) providing largest time savings for group; the common route segment is MP to RCF
- MFCR advisory has the following features:
  - Routes avoid forecast weather (CWAM polygons) from MSP to RCF
  - Each flight in group has an individual time savings of at least 3 minutes
  - Total time savings for the group is at least 10 minutes