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

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Outline

• Background on Multi-Flight Common Routes (MFCR)

• Human-in-the-Loop evaluation of MFCR

• Key Results

• Conclusions
Multi-Flight Common Routes (MFCR) identifies opportunities for delay recovery by refreshing outdated routes.
Example MFCR Advisory

MFCR advisory has 9 flights with a total of 53 minutes time savings
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

37% of Initial Advisory ratings were acceptable
81% of Final Advisory ratings were acceptable
Details of Acceptability Ratings

HITL Evaluation of MFCR Advisories
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

Average TLX rating = 1.1

NASA TLX Components:
- Mental Demand
- Physical Demand
- Temporal Demand
- Effort
- Performance
- Frustration
Acceptability of MFCR Operations

Statement: MFCR operations were acceptable
1 = Disagree  4 = Neutral  7 = Agree

66% of Advisory ratings were for high acceptability of MFCR operations (rating of 6 or 7)
Strategy for Dynamic Advisories

Statement: Wait to issue MFCR advisory
1 = Disagree  4 = Neutral  7 = Agree

Issue advisory immediately: 55%
Wait a few minutes for more flights to join: 25%
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

Details of MFCR Advisory

ELP is the Return Capture Fix for MFCR Route

Sector Congestion: Playbook

Sector Congestion: MFCR

MFCR Route

Playbook Route
Limit Polygon, Return Capture Fixes
MFCR Concept of Operations

• Traffic Manager evaluates/modify the re-route advisory
  – TM coordinates (possibly using AFST interface) with:
    o TMUs of affected Centers; ATC System Command Center
    o Area Supervisors of sector controllers who “own” the affected flights
    o 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