3D-Path Arrival Management (3DPAM): Simulations and Field Tests

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3DPAM Concept

Ground automation generates *comprehensive* arrival clearance

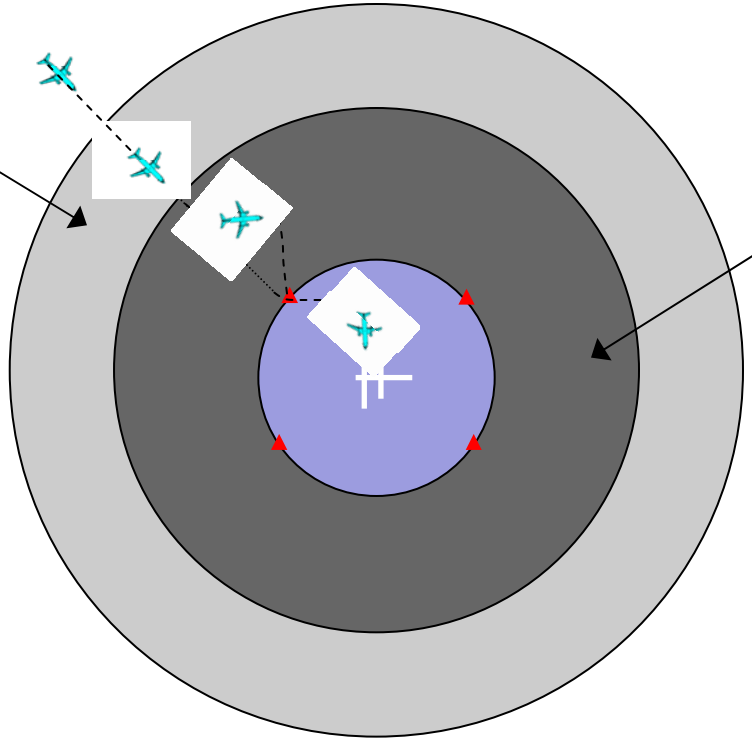
- Trajectory-based, metering conformant, conflict free
- Designed for efficient, continuous descent to TRACON meter fix
- Issued via voice (future: datalink)

Airborne automation provides guidance and control along the pre-planned arrival trajectory

- FMS generates guidance trajectory to meter fix based on 3DPAM clearance (includes top-of-descent derivation)
- Couples with autopilot for lateral and vertical path management

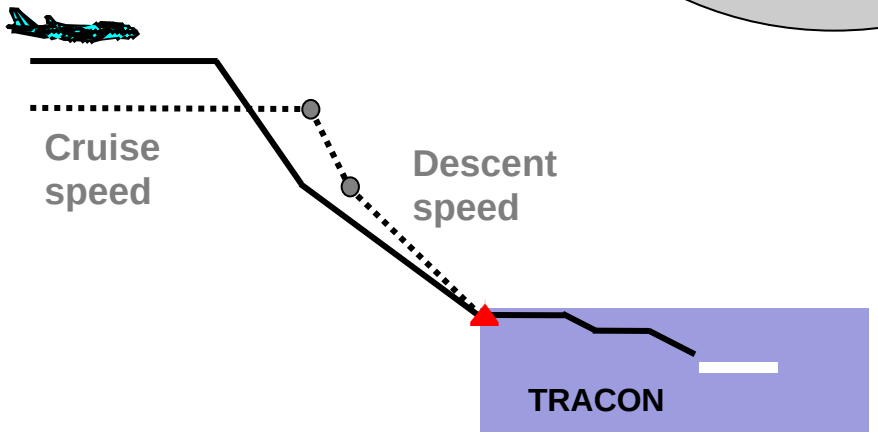
En Route Descent Advisor (EDA)

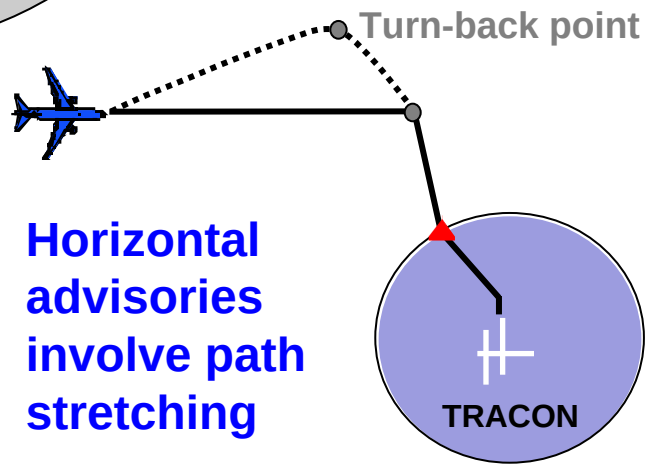
Traffic Management Advisor (TMA) plans sequence and schedule to TRACON meter fix



EDA generates advisories to meet TMA schedule

Vertical advisories involve cruise and descent speed



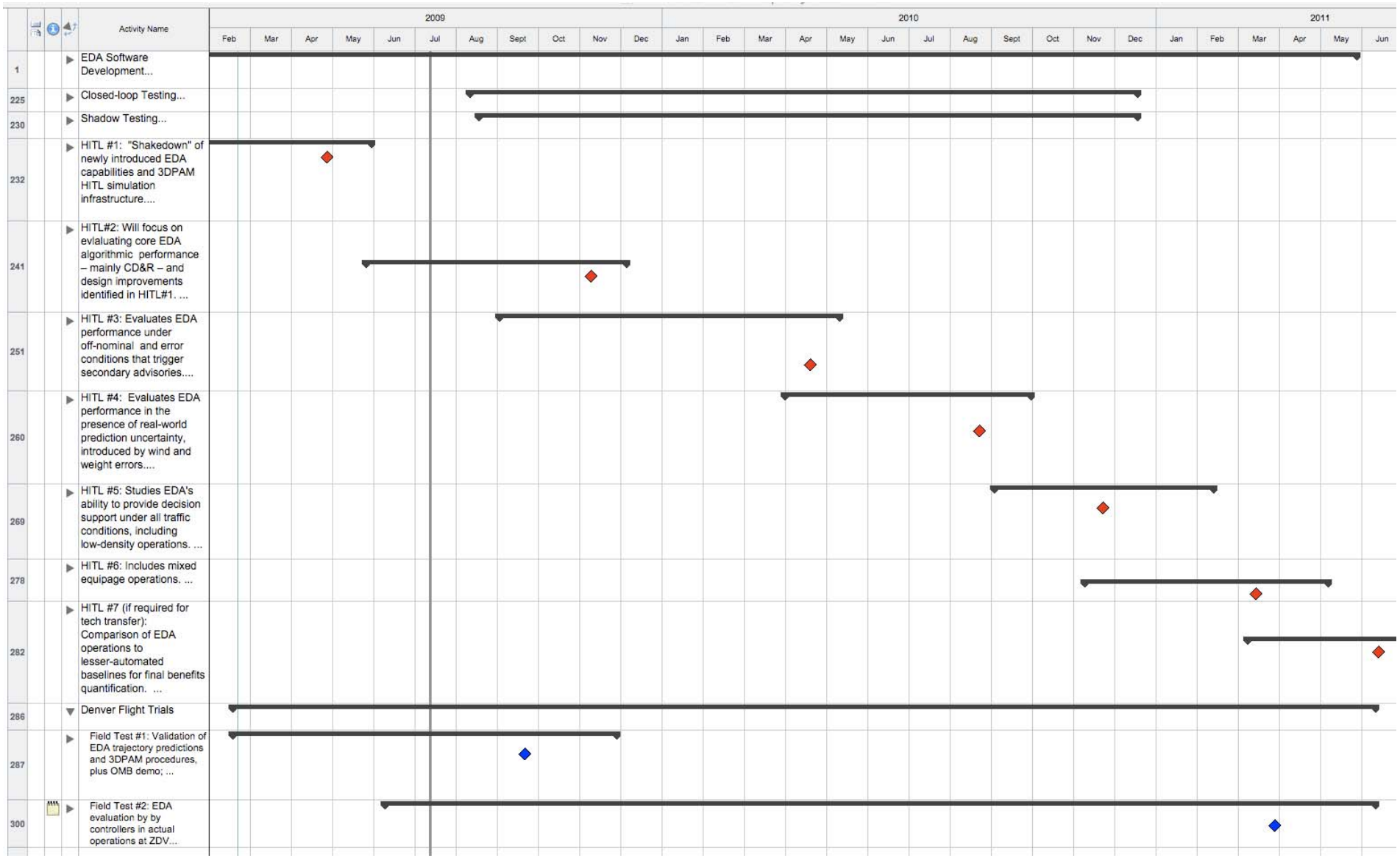


Horizontal advisories involve path stretching

3DPAM Project Overview

- Collaborative effort between NASA, FAA, and Boeing, with support from United and Continental Airlines
- Simulations and field experiments will focus on Denver Center
  - Denver controller team formed to assist with iterative design and development
  - “Build a little, test a little” development approach
- NASA’s efforts are aimed at developing and validating EDA for tech transfer to the FAA
  - Technology transfer will start in 2010
  - FAA final investment decision in 2012
  - EDA deployment targeted for 2015
  - Deployment expected to occur within FAA’s En Route Automation Modernization (ERAM) system, Post Build 3
  - FAA collaboration guided by the Efficient Flow Into Congested Airspace (EFICA) Research Transition Team

3DPAM: High-Level Project Schedule



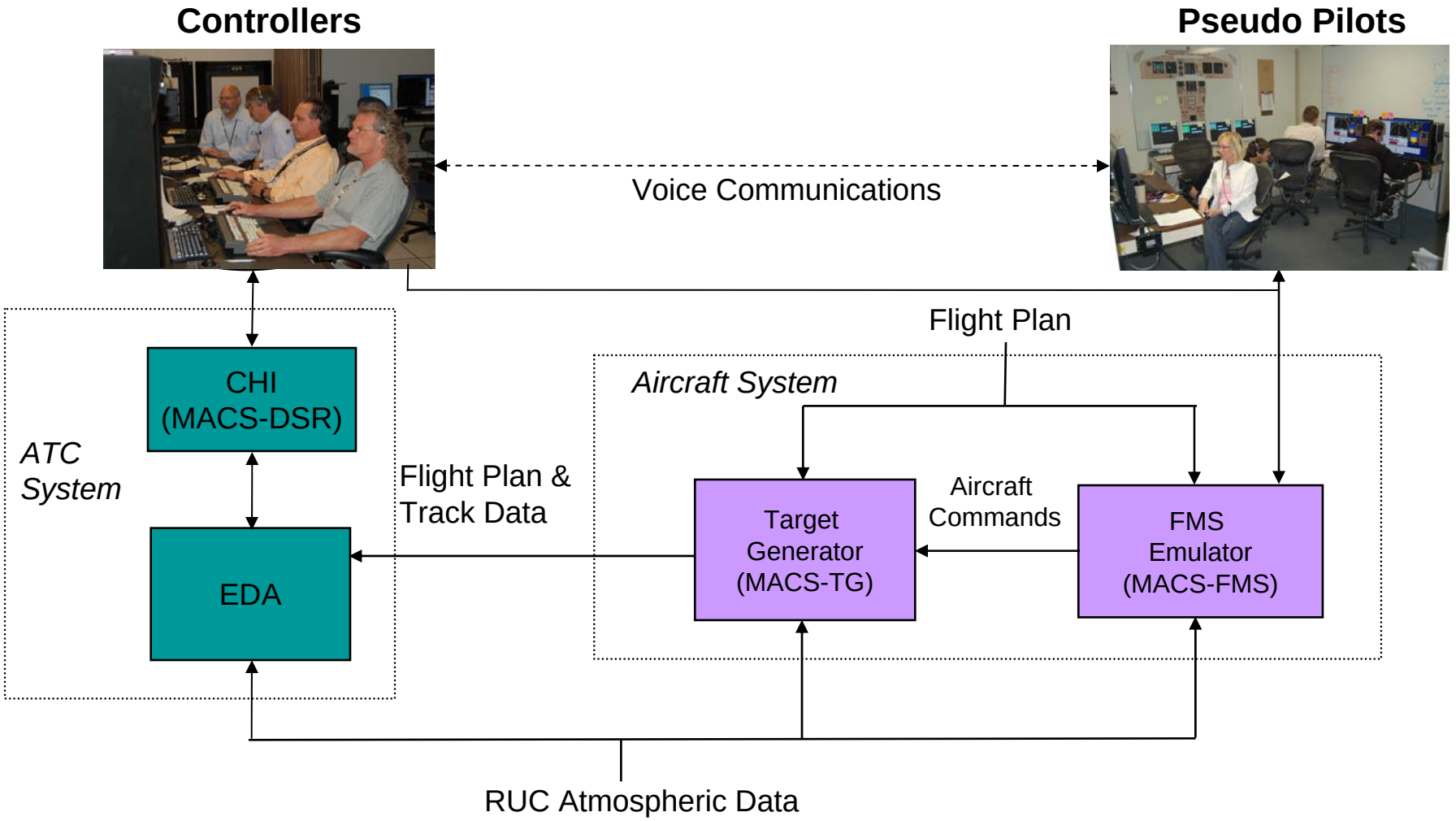
HITL Simulation #1

April 2009

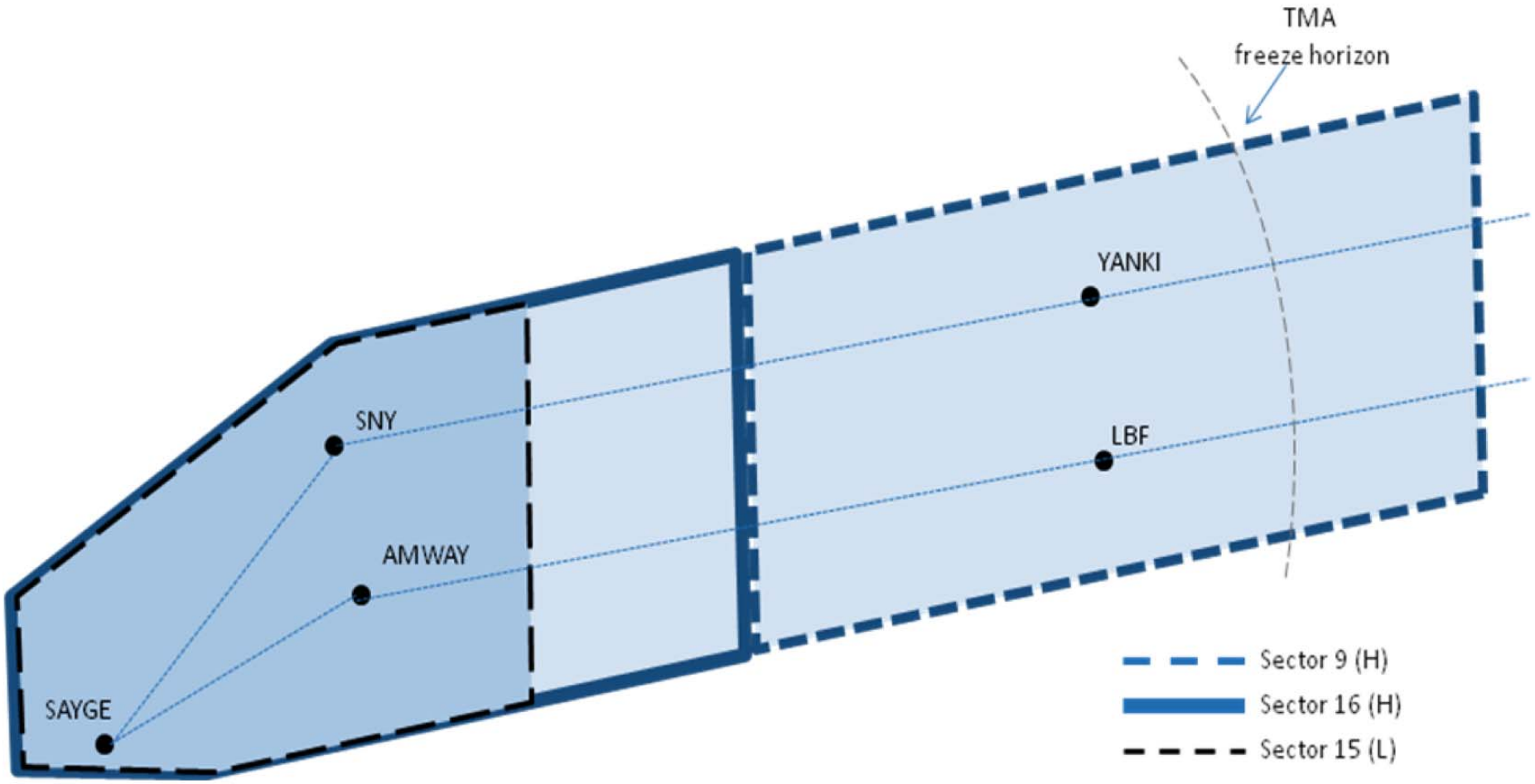
Simulation Objective

Obtain controller feedback on EDA system performance and user interface, as implemented to support the 3DPAM concept of operations

HITL Simulation System



ZDV Airspace



Concept-Related Findings

- Forward-looking, trajectory-based arrival solutions require a different level of situational awareness than for current-day operations
- Controllers expressed interest in using cruise-altitude changes for conflict resolution
- Controllers like idea of giving the entire arrival clearance as early as possible – for simplicity and workload reasons – but have some procedural concerns:
  - Today, controllers protect airspace to accommodate a descent at any point after a descent clearance is issued
  - 3DPAM requires an expectation that aircraft will descend only at their FMS-predicted TOD. This is a psychological shift for controllers
  - Shared awareness of FMS TOD is important. In the future, data-link provides an obvious solution. TOD concern was alleviated in the simulation by requiring aircraft to report when ~10 nmi from FMS-predicted TOD

HITL#1 Demo

Field Test #1
September 2009

Field Test #1: Objective

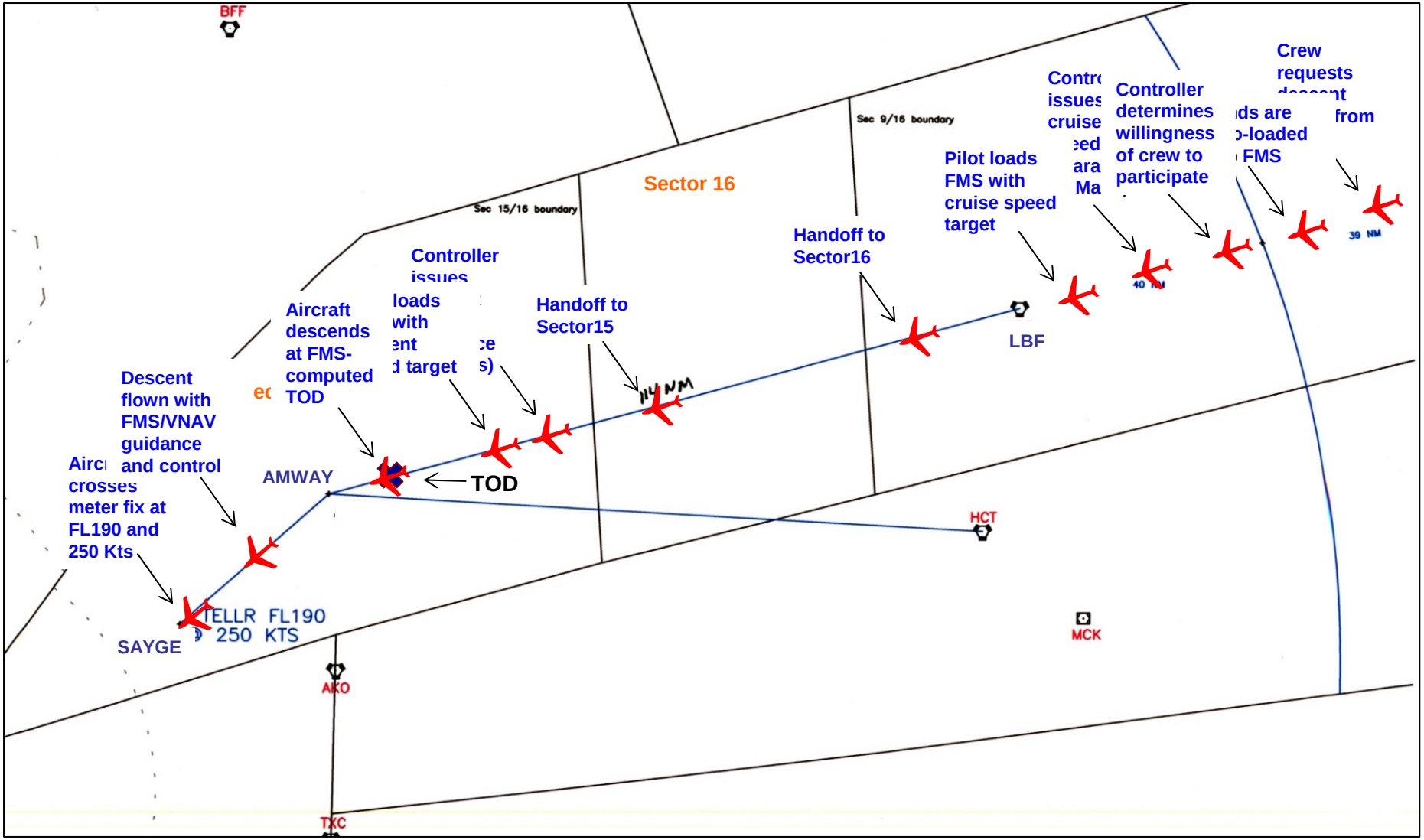
1. Assess the accuracy and precision of EDA trajectory predictions, upon which 3DPAM clearances are based
   - Quantify TOD, along-track, and vertical trajectory-prediction errors
   - Use results to help develop trajectory uncertainty models for use in upcoming simulations
2. Help the FAA meet its milestone for demonstrating 3DPAM operations at Denver Center by Sept. 2009

Field Test #1: Description

- Flight trials scheduled to begin Sept 8, 2009
- UAL, COA and FAA Tech-Center flights
  - UAL: B757, B737, and A319/A320
  - COA: B737-800, B737-900
  - FAA Tech-Center: Bombardier Global 5000
- Commercial operations:
  - Minimum of 2 weeks and 200 flights
  - Maximum of 4 weeks
- FAA flight operations (Tech Center):
  - OMB demo activity 9/15-16
  - Data flights 9/21-25; approx 5 flights per day
- Pre-scripted clearances; no EDA automation
  - UAL/COA flights will receive speed clearances
  - FAA flights will receive speed and path clearances

Field Test #1: Sequence of Events

Speed-Only Example



Field Test #2

- Planned for March 2011
- EDA prototype deployed for real-time decision support
- Advisories presented on the DSR glass for operational integrity
- Two controller positions at test sector
  1. EDA controller (Test R-side)
     - Uses an auxiliary display to control traffic (DSR-like functionality)
     - When test is underway, EDA controller issues all voice clearances
  2. Safety Controller (True R-side)
     - Provides safety back-up during test – can terminate at any time
     - May provide some nominal ATC support functions - TBD (e.g., accepting hand-offs, etc)

Summary

- EDA automation and procedures have been adapted to the 3DPAM concept, aimed at providing near-term OPD benefits in congested en route airspace
- Tech-transfer process will involve a series of HITL simulations and field tests through 2011
- April simulation (HITL#1) was a “shakedown” activity used to refine the EDA prototype and simulation environment in preparation for more formal evaluations
- Despite some early system-performance issues, controllers found the concept “very workable”, with confidence improving as the week progressed
- Situational awareness of intended trajectory, especially TOD, is a concern, but appears solvable through a combination of automation and procedures
- Work is underway in preparation for HITL#2 (Nov 2009), and flight trials at Denver Center (Sept 2009)