Using Data Communications to Manage Tailored Arrivals in the Terminal Domain: A Feasibility Study

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June 14, 2011

Introduction

- **Federal Aviation Administration (FAA) has developed a multi-step Research Management Plan (RMP) for Segment 2 Data Communications (Data Comm) Implementation**
  - **Segment 1 (2012-2018): Tower, En Route**
  - **Segment 2 (2018-2022): Terminal, En Route**
- **CAASD was been tasked to evaluate the operational feasibility of using Data Comm in the Terminal domain to manage traffic with Tailored Arrival operations**

Introduction, cont'd

- **Data Comm:**
  - **Text-based mode of communication**
  - **An alternative to voice communication**
  - **Requires ground-based equipment**
  - **Requires appropriate avionics**

Introduction, cont'd

- **TA:**
  - **A route clearance that is tailored, laterally and/or vertically, on a per-flight basis, to satisfy operational constraints**
  - **Generated by automation to be initially conflict-free**
  - **The route defines an Optimized Profile Descent (OPD) from Top of Descent to the runway**
  - **Data Comm is required to communicate the clearance**
  - **Flight Management System (FMS) with integrated Data Comm is required to auto-load the clearance**

Introduction, cont'd

- **Obstacles to using TAs in the USA today:**
  - **Data Comm not available in domestic airspace**
  - **No automation to generate TA routes**
- **Initial Tailored Arrivals (ITA):**
  - **Use Data Comm services available in ATOP/Ocean21™; limited to international arrivals**
  - **Predefined (but unpublished) routes available to both ATC and pilots; not in the FMS**
  - **Requires FMS/Data Comm integration**
  - **Currently in use at SFO, LAX, and MIA**
  - ***Managed by voice in the Terminal***

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Terminal Domain Issues

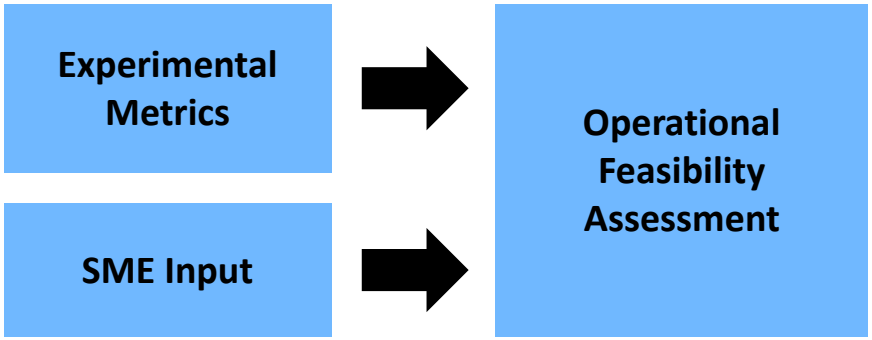
- **Data Comm:**
  - **Transaction time is greater than voice**
  - **Terminal airspace is tactical/time-critical**
- **TA:**
  - **Can introduce route variability and uncertainty**
  - **May increase cognitive loading on the Terminal controller**

Hypothesis

- **There will be performance differences as a function of *route familiarity***
  - **TA routes: unfamiliar to Terminal controllers**
    - **generated by automation in en route**
    - **issued by en route controllers**
    - **no graphical display of flight plan route in automation**
  - **ITA routes: more familiar to Terminal controllers**
    - **they are predefined**
    - **limited number**
    - **used often**

Approach

- **Assessment of operational feasibility based on:**
  - **Metrics gathered through a human-in-the-loop simulation study**
  - **ATC Subject Matter Expert (SME) input based on experience with the study**



Study Design

	Operational Condition
Baseline Condition (How ITAs are performed today)	TA Data Comm and voice
Target Condition	
Intermediate Condition	

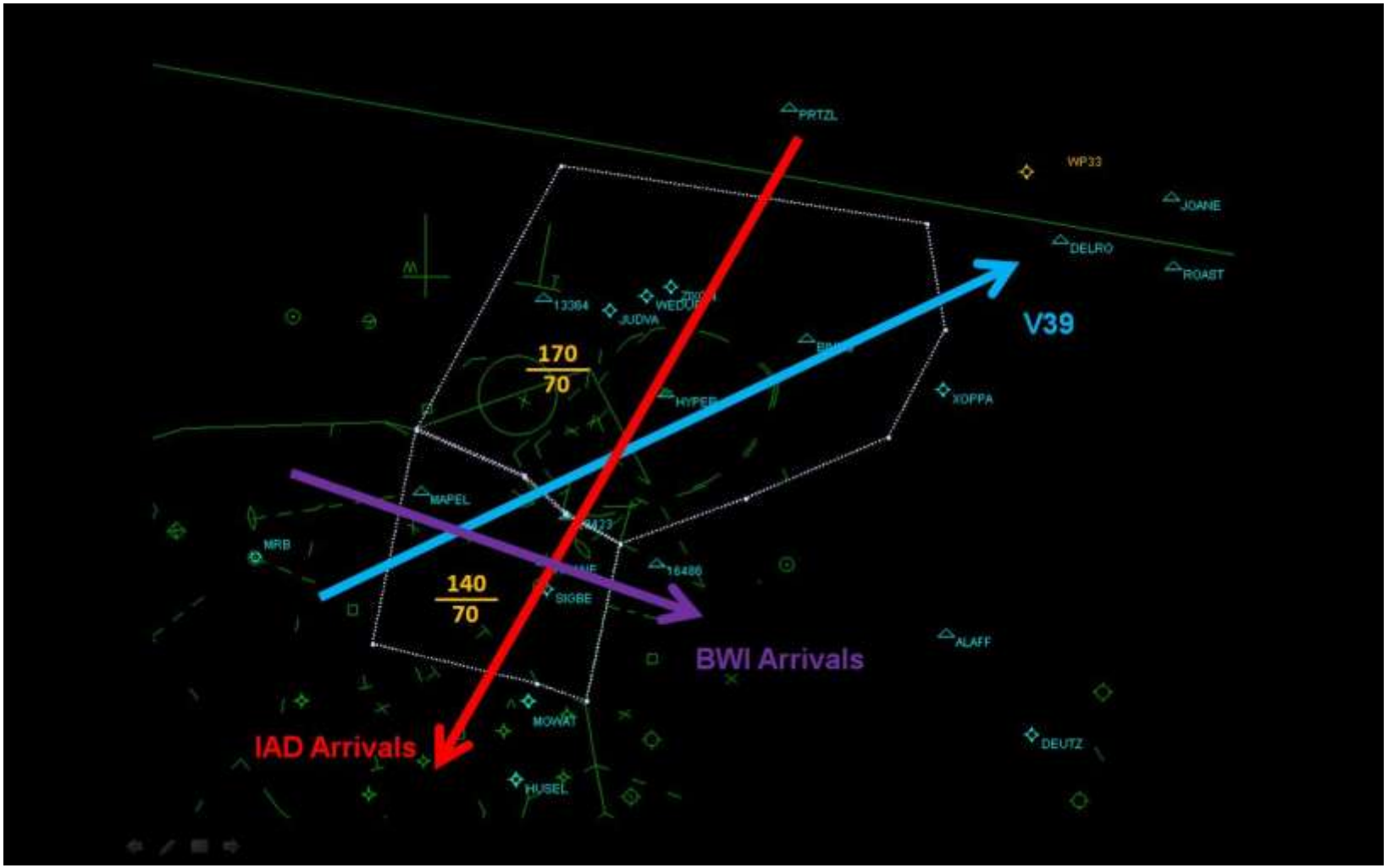
Study Design, cont'd

- **Isolate effects of:**
  - **Comm modality (voice only, Data Comm and voice)**
  - **Data Comm Equipage Levels (35-40%, 65%)**
  - **Operational Condition (ITA, TA)**
  - **Traffic Load (80%, 100% capacity)**
- **Within-subjects study**

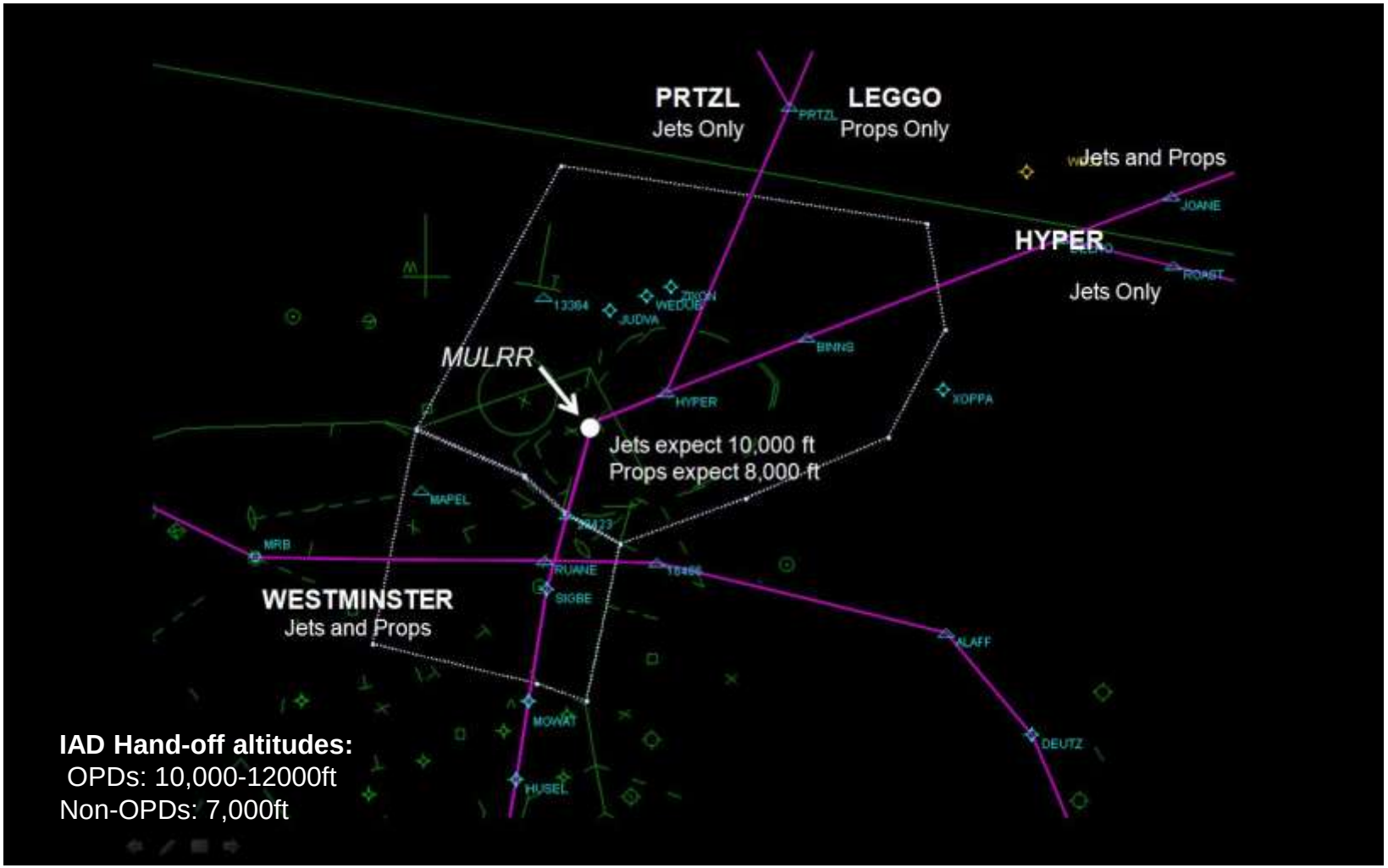
Study Design, cont'd

- **Traffic:**
  - **FMS equipped with LNAV and VNAV capabilities**
  - **Mix of conventional, RNAV, ITA or TA**
- **Ten, 30-minute scenarios**
  - **Each scenarios included six scripted spacing conflicts**
  - **Scripted conflict pairs consisted of all available combinations of equipage and arrival type**

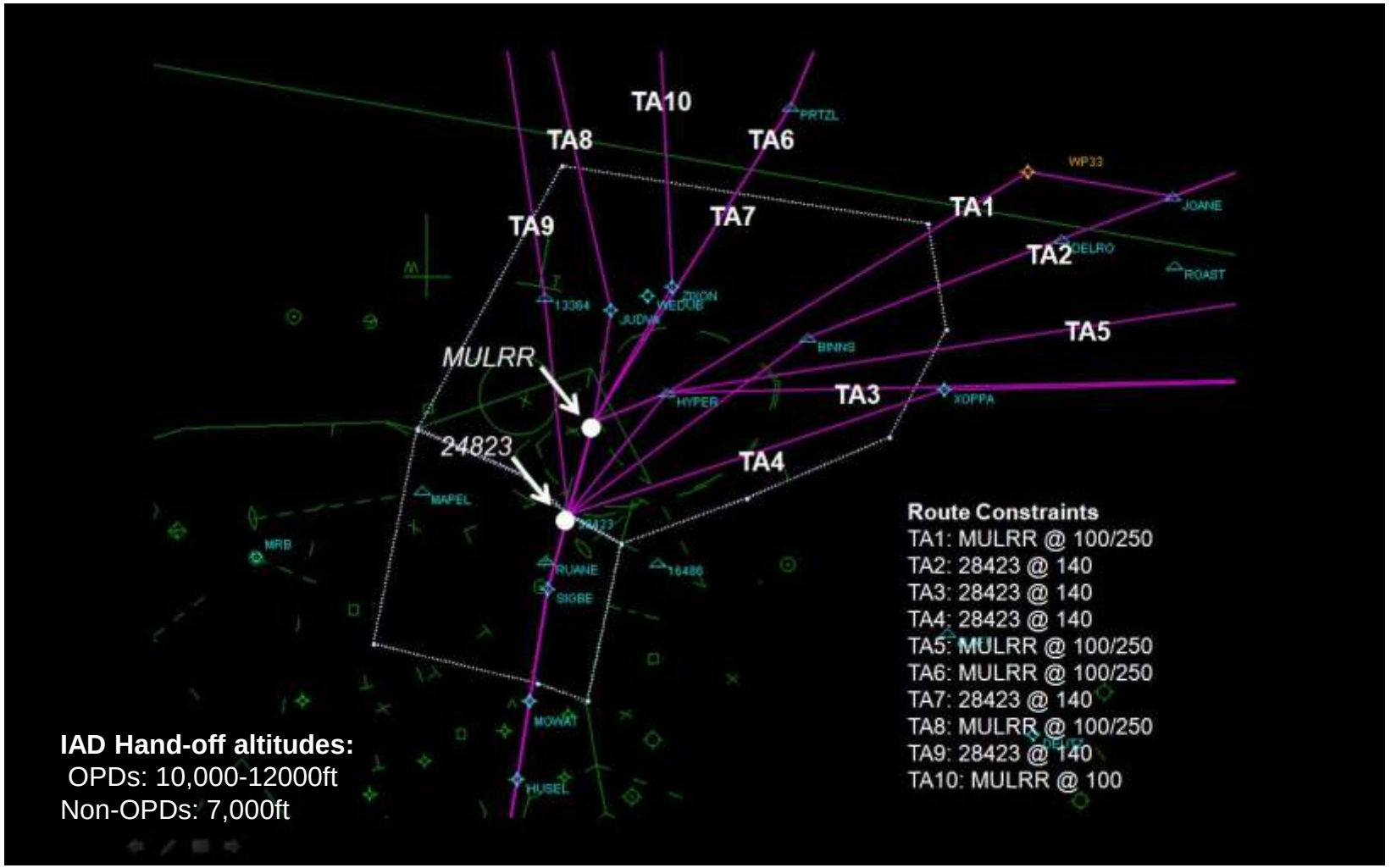
Airspace



Routes: Published Procedures



Routes: TAs



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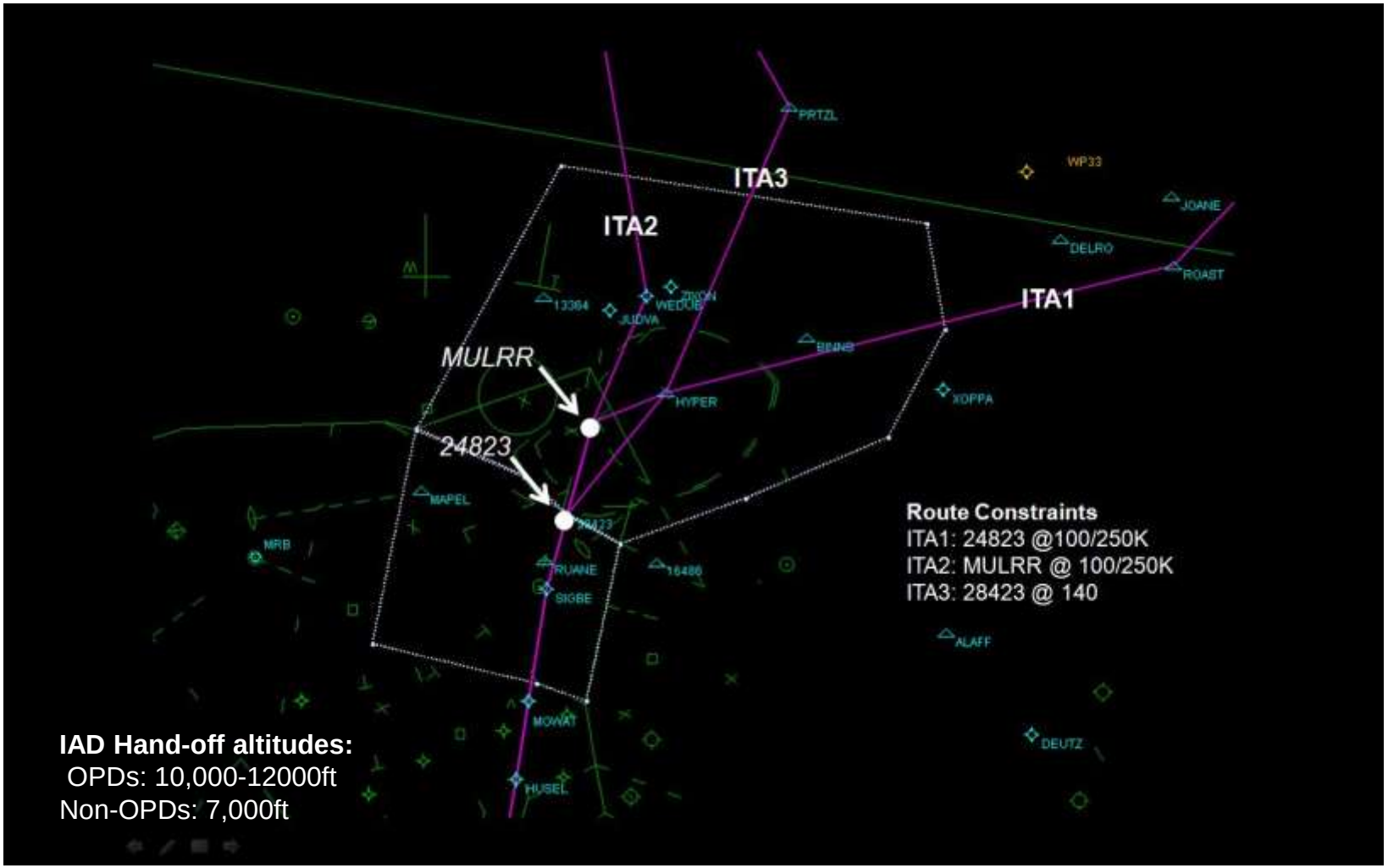
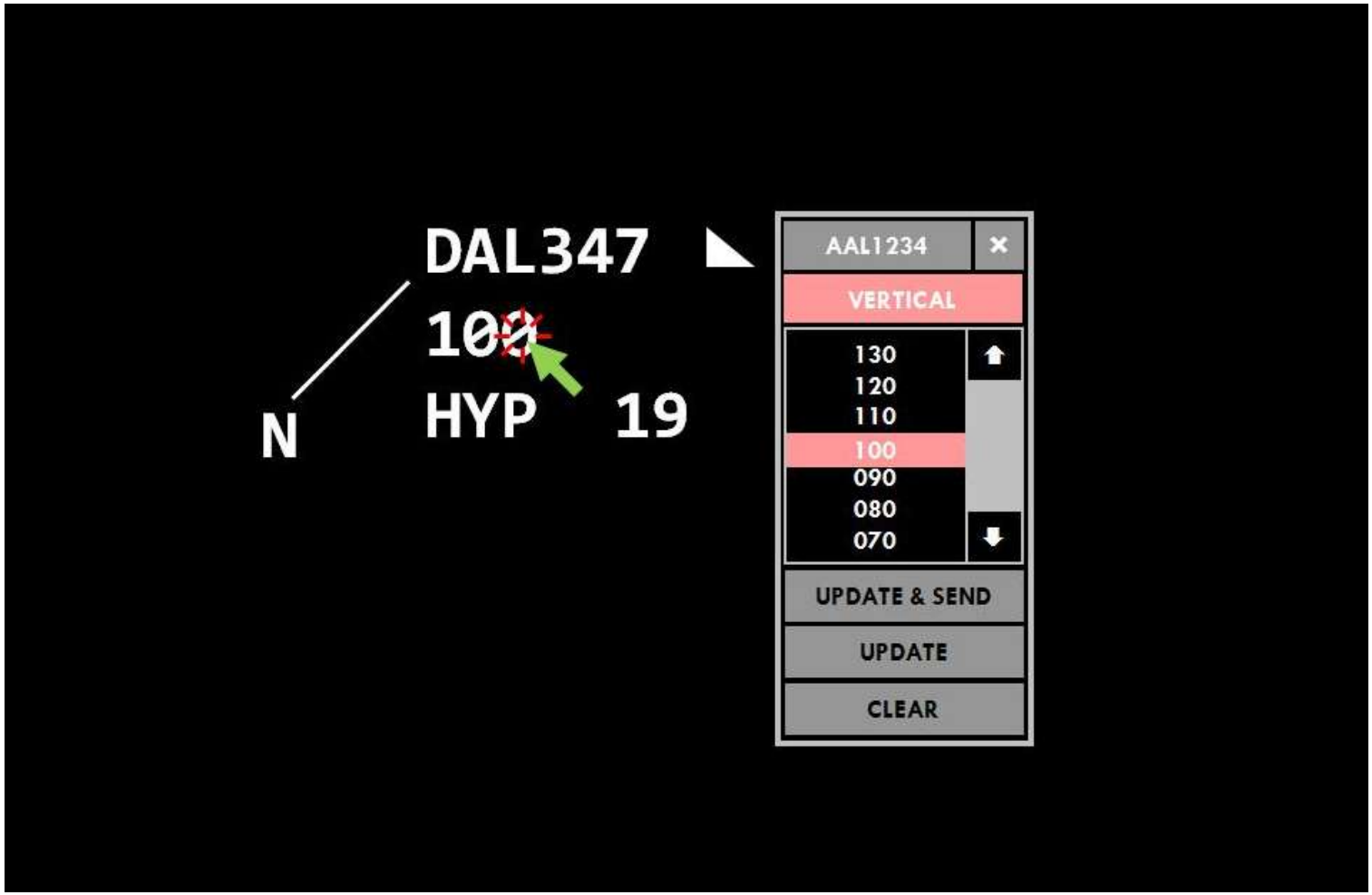
Routes: ITAs



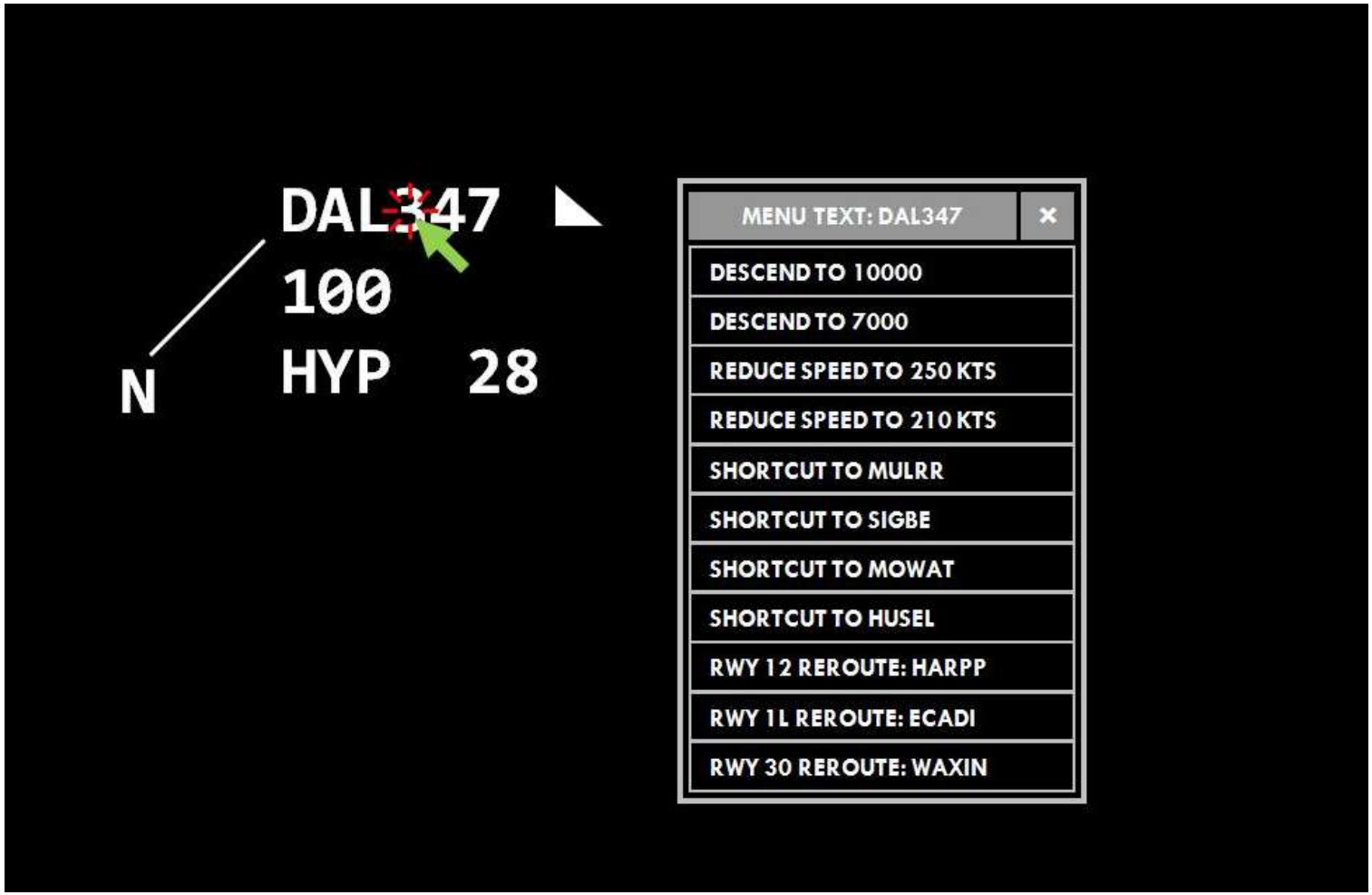
Apparatus

- Study performed in CAASD's ATM Laboratory
- TARGETS-based simulation:
  - Capability to graphically display routes
- Leveraged Tech Center's FTWS/FEWS research
  - Data Comm GUI and infrastructure
  - Interactive datablock
- Touch screen used to record subjective workload
- Applied Science Laboratories MobileEye tracker

Data Comm GUI: Flyout



Data Comm GUI: MENU TEXT



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Participant Workstation

Participants

- 12 Retired Certified Professional Controllers
- Age: Mean=53; SD=6
- Years controlling traffic: Mean=21; SD=8
- Familiarity with RNAV operations: 92% Yes
- Experience with RNAV SIDs/STARs: 58% Yes
- Prior participation in a MITRE study: 67% Yes
- Prior participation in a Data Comm HITL simulation: 92% No

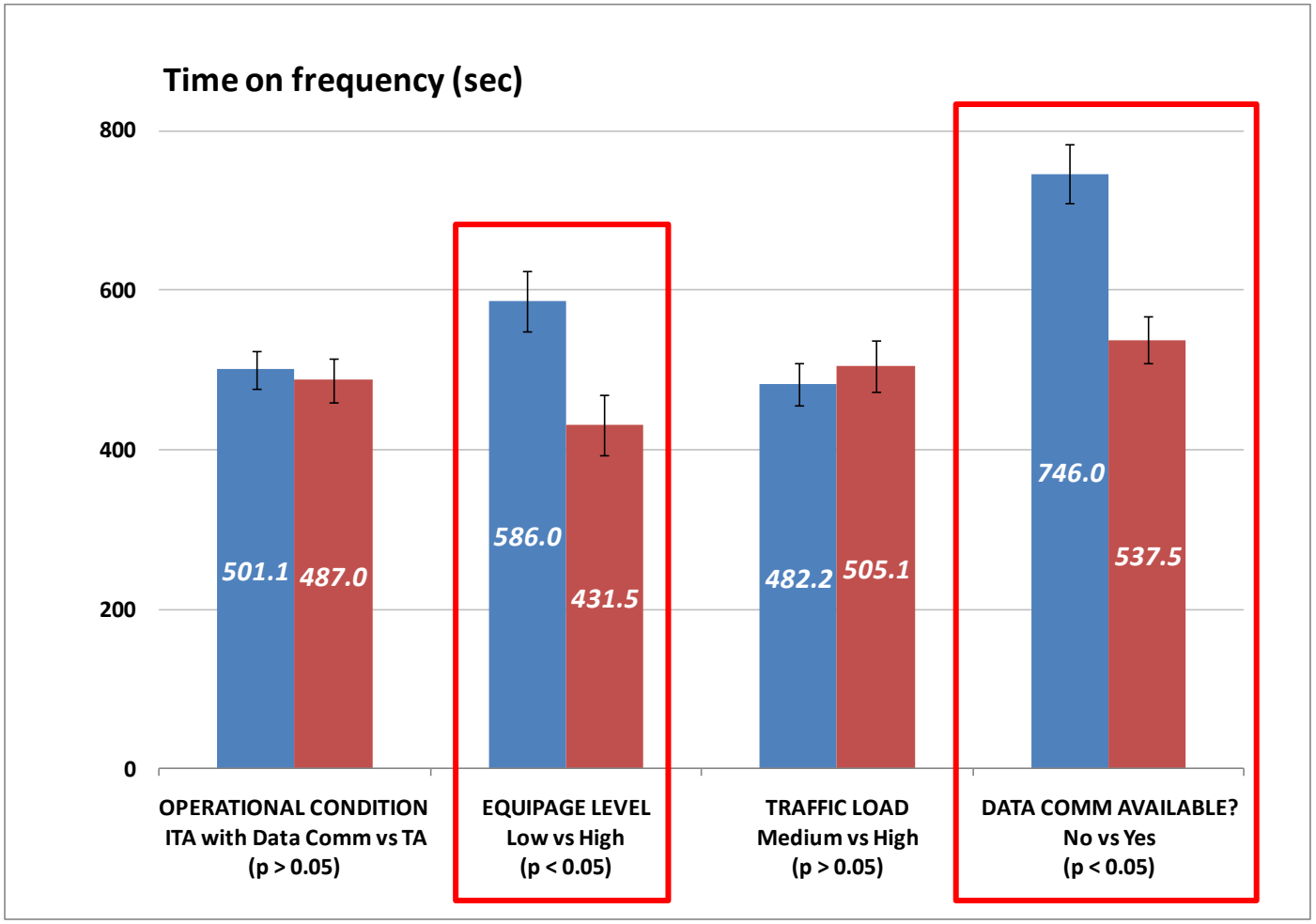
Instructions

- **Encouraged to:**
  - **Maintain efficient descents**
  - **Use Data Comm**
- **Data Comm use and maintenance of OPDs are ultimately at the controller's discretion**
- **Safe, orderly, and expeditious flow of traffic**

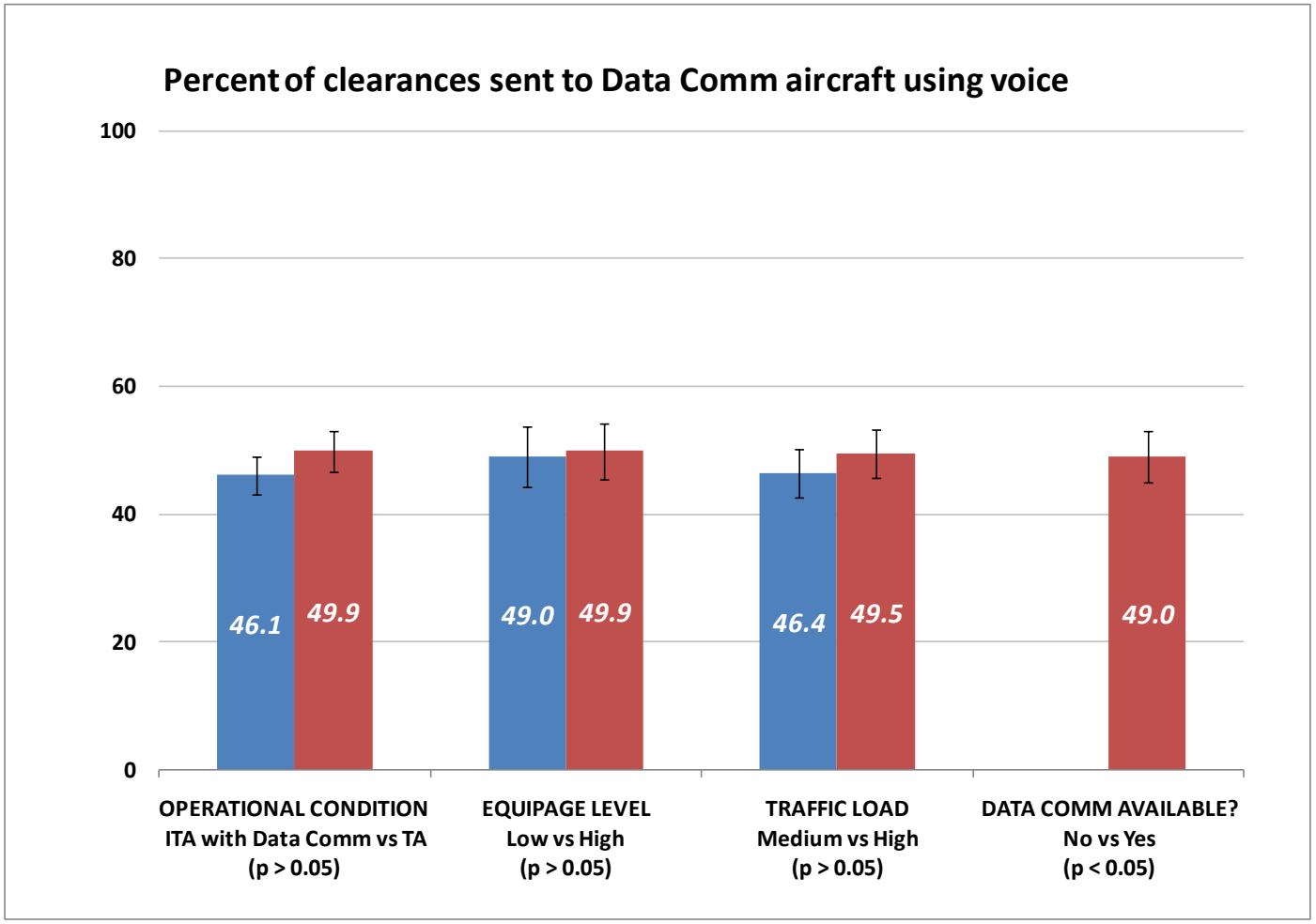
Metric Categories

- **Traffic Management Strategies and Decisions:**
  - **voice comm time on frequency**
  - **workload**
  - **modality used to separation scripted spacing conflicts**
- **Efficiency of Service:**
  - **number interrupted OPDs**
  - **percent of completed OPD path**
- **Safety:**
  - **number of loss of separation events**
  - **controller responsiveness to scripted spacing conflicts**

Selected Results



Selected Results, cont'd



Selected Results, cont'd

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Selected Results

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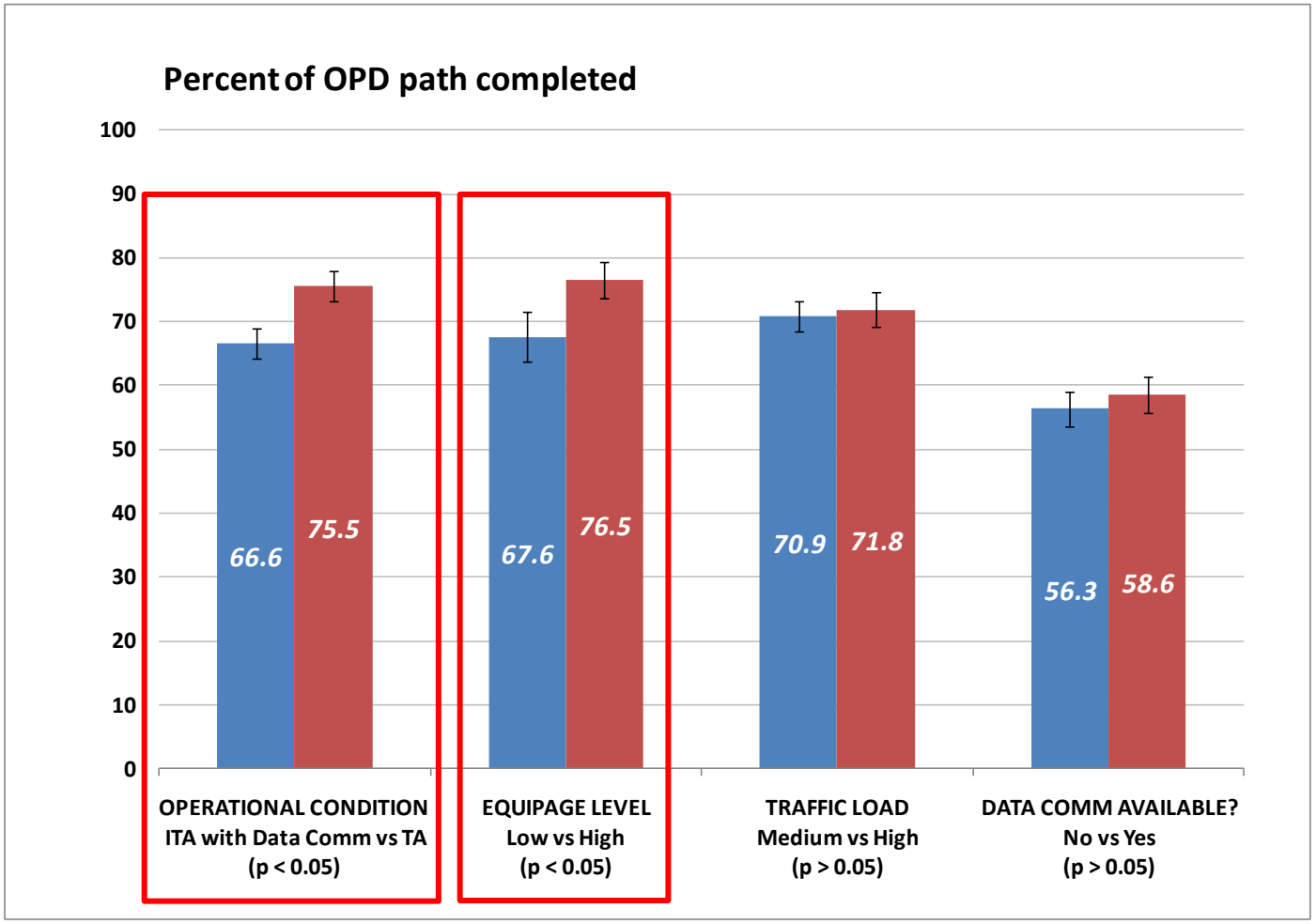
Selected Results, cont'd



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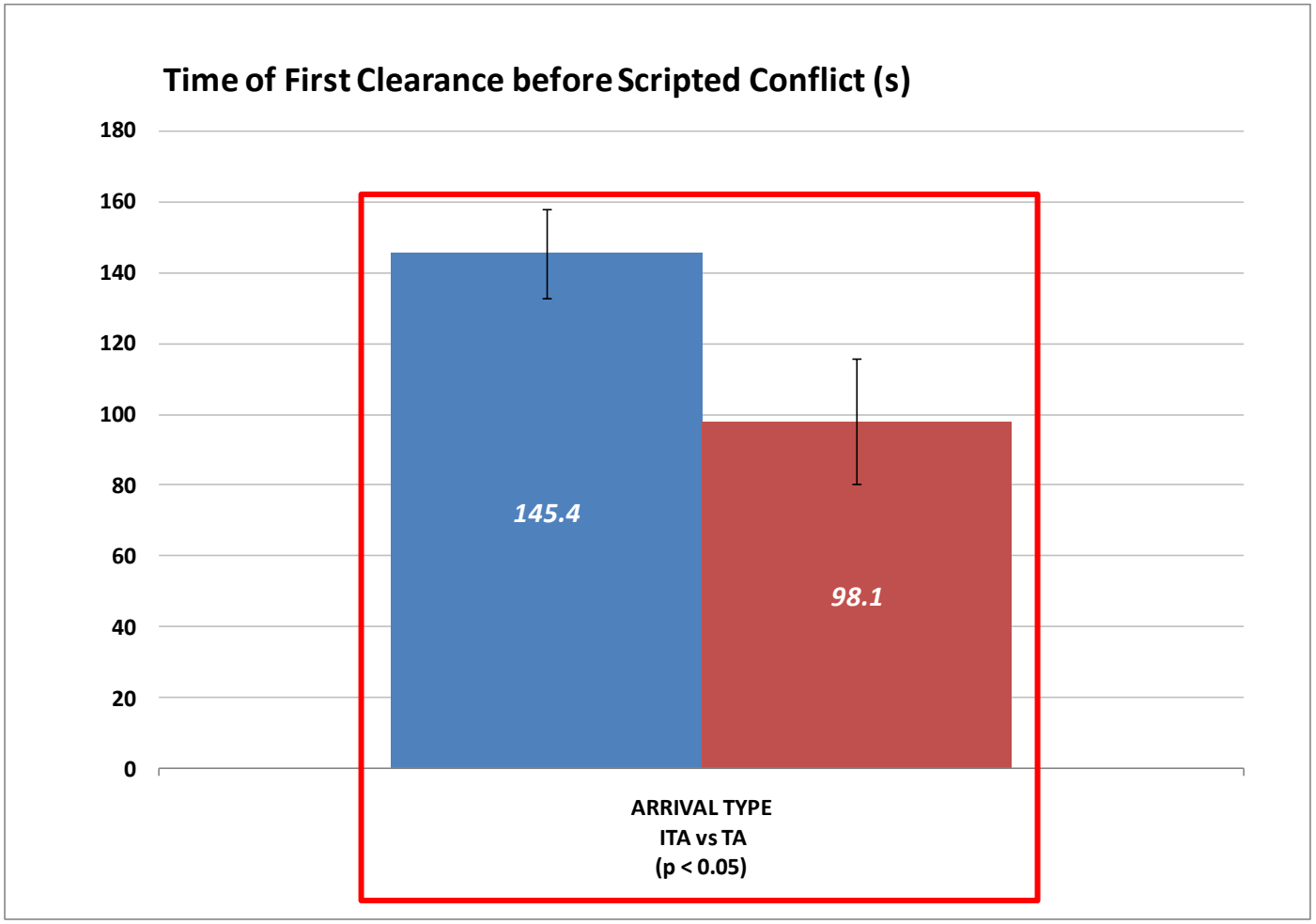
Selected Results, cont'd



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Operational Feasibility Assessment

- **Meeting with 7 MITRE ATC SMEs:**
  - **three study advisors; four study participants**
- **Concerning Use of Data Comm in the Terminal:**
  - **Well suited for departure, feeder, final positions**
- **Concerning ITA operations:**
  - **operationally feasible using the systems present in our simulation**
- **Concerning TA operations:**
  - **operationally feasible only with decision support tools, such as conformance monitoring, conflict probe, and/or Relative Position Indicator (RPI)**

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Conclusions

- **Hypothesized a route familiarity effect**
  - **time before conflict for first clearance**
- **Initial assessment of operational feasibility:**
  - **Data Comm can be very useful in Terminal operations**
  - **TAs need support tools such as conformance monitoring**
  - **ITAs at much higher rates than seen now in the ITA trials are manageable using current Terminal automation**

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