National Aeronautics and Space Administration

Terminal – Tactical Separation Assured Flight Environment (T-TSAFE)

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Outline

- Objective
- Motivation
- Comparison with previous research and current operations
- Integration with SDO Concept
- T-TSAFE details
- Experiment Plan
- Summary

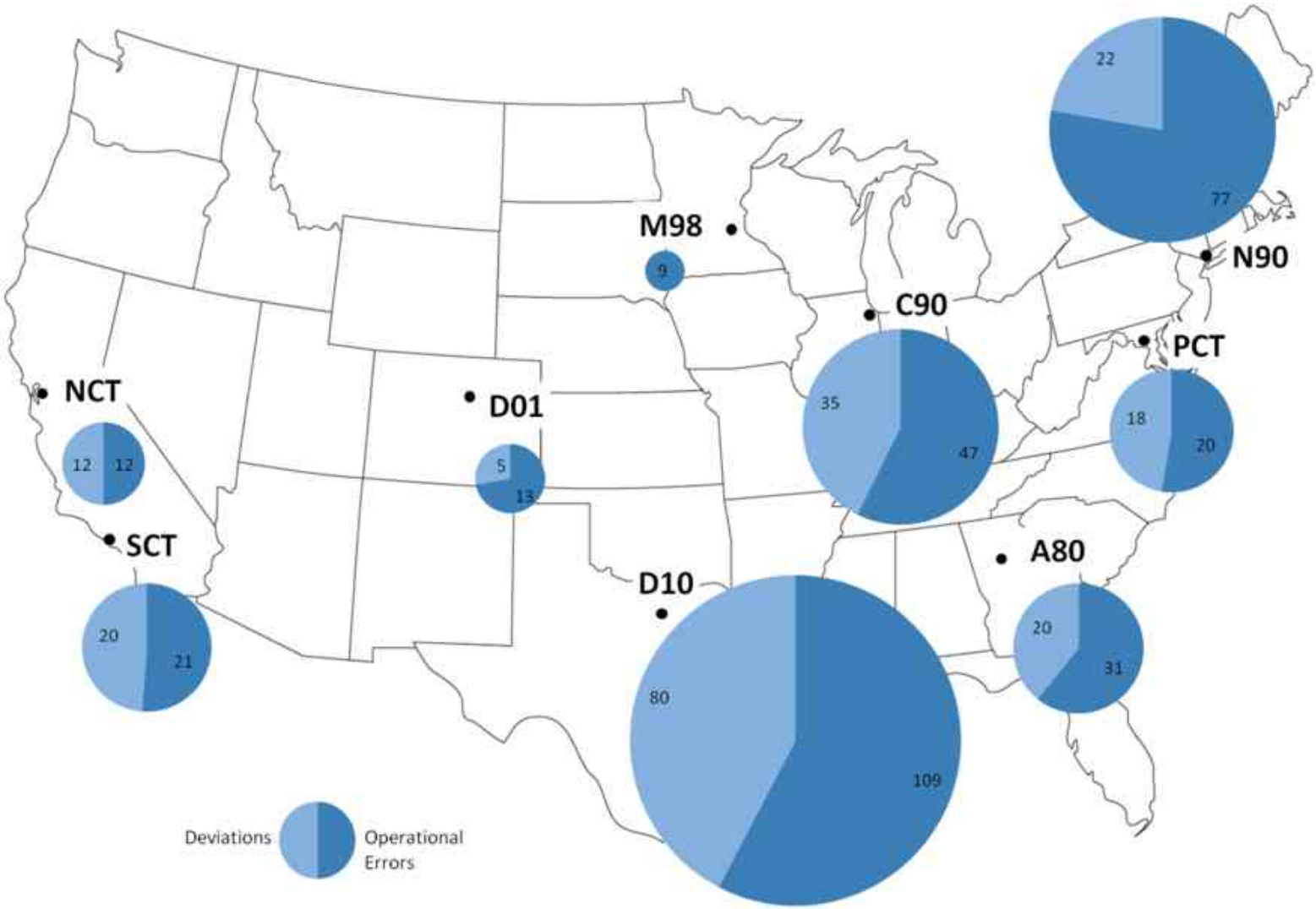
Objective

Conduct simulations of initial tactical conflict prediction and resolution advisory functions

- Develop, define and test controller procedures and roles and responsibilities
- Identify information requirements
- Evaluate and compare the tool with current day tools such as Conflict Alert

TSAFE = Tactical Separation Assured Flight Environment

Operational Errors and Deviations
(Selected TRACONs, 2009)



Roach (2011). North Texas Research Facility

Motivation

- Conflict Alert (CA) is inadequate
  - Insufficient flight plan detail to the runway
  - Complex separation standards
- Terminal airspace is challenging
  - Operational errors are high
  - Dense and complex airspace
- Previous research has clear gaps

Background

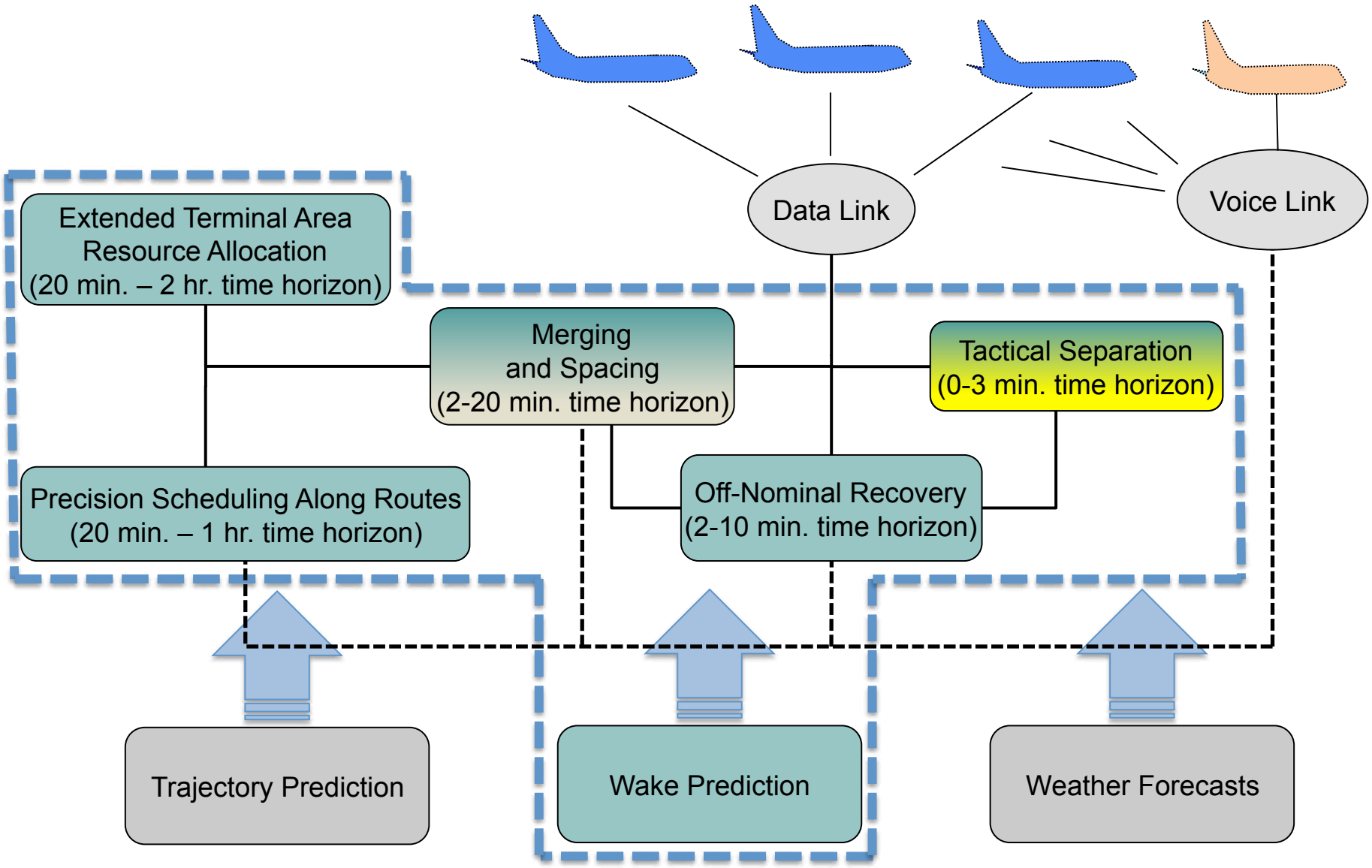
Previous Research on TSAFE (Prevot et al.)

- En route HITL testing
- Automated conflict detection and resolution
- Management by exception
- All resolution trajectories are data linked

T-TSAFE & Current Operations

- Terminal area HITL testing
- Conflict detection is automated but resolution is manual
- Controllers responsible for separation assurance
- Voice commands

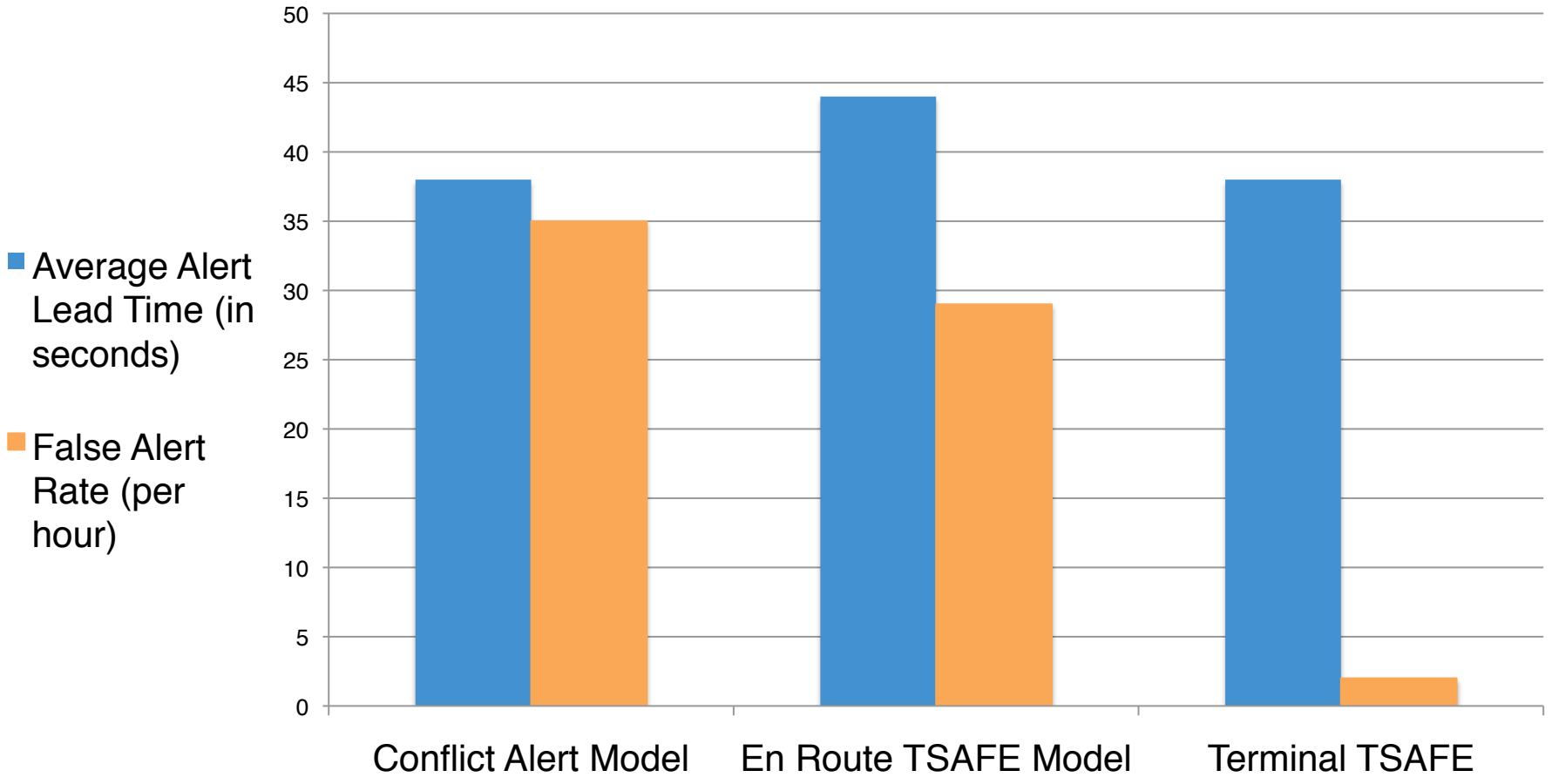
Integration with SDO concept



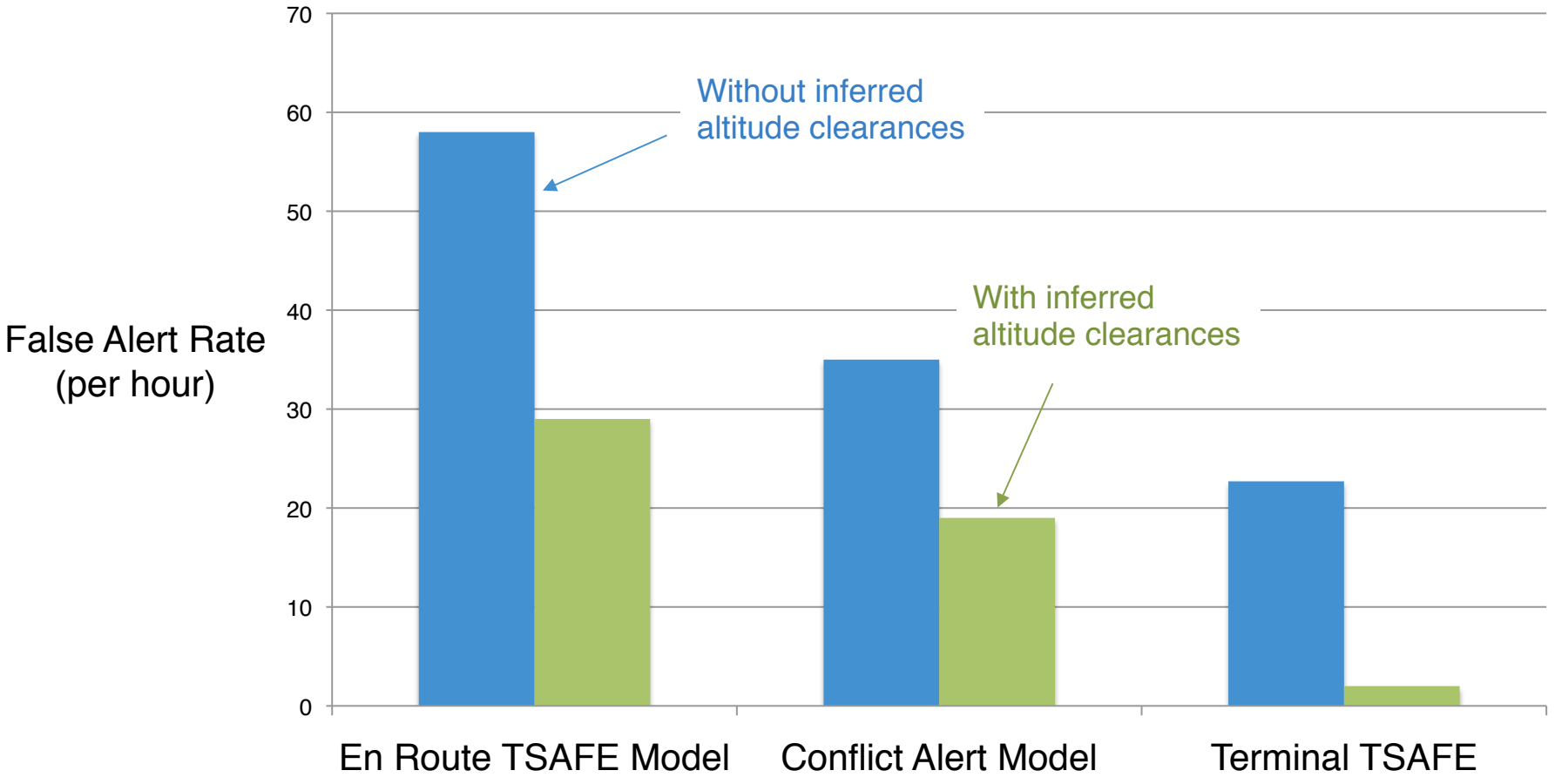
What is T-TSAFE?

- Short-term conflict detection tool for terminal airspace
- Based on similar principles as en route TSAFE (Erzberger's tool)
- Provides two-minute resolution trajectory without returning to flight plan route
- Uses dead reckoning and flight intent information separately or in combination when flight Intent is present

Algorithm Comparison
T-TSAFE vs. Conflict Alert (Tang et al.)



False Alerts (Results for lab analysis Tang et al.)



False alerts further improved if altitude (flight intent) information is present

Experiment Matrix

March-April 2011

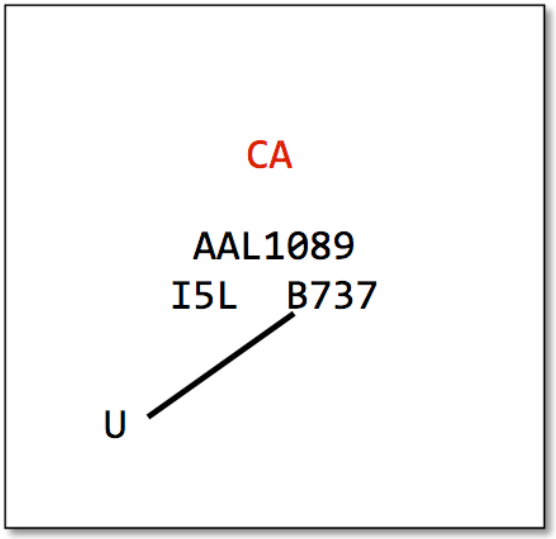
Altitude Entries	Baseline (Conflict Alert and ATPA)	T-TSAFE (Conflict detection only) and ATPA
None	Condition A	Condition B
Keyboard	NA	Condition C
ADS-B	NA	Condition D

Multi Aircraft Control System (MACS) used to integrate the T-TSAFE algorithms, ATPA, CA and develop user interfaces

ATPA = Automated Terminal Proximity Alert

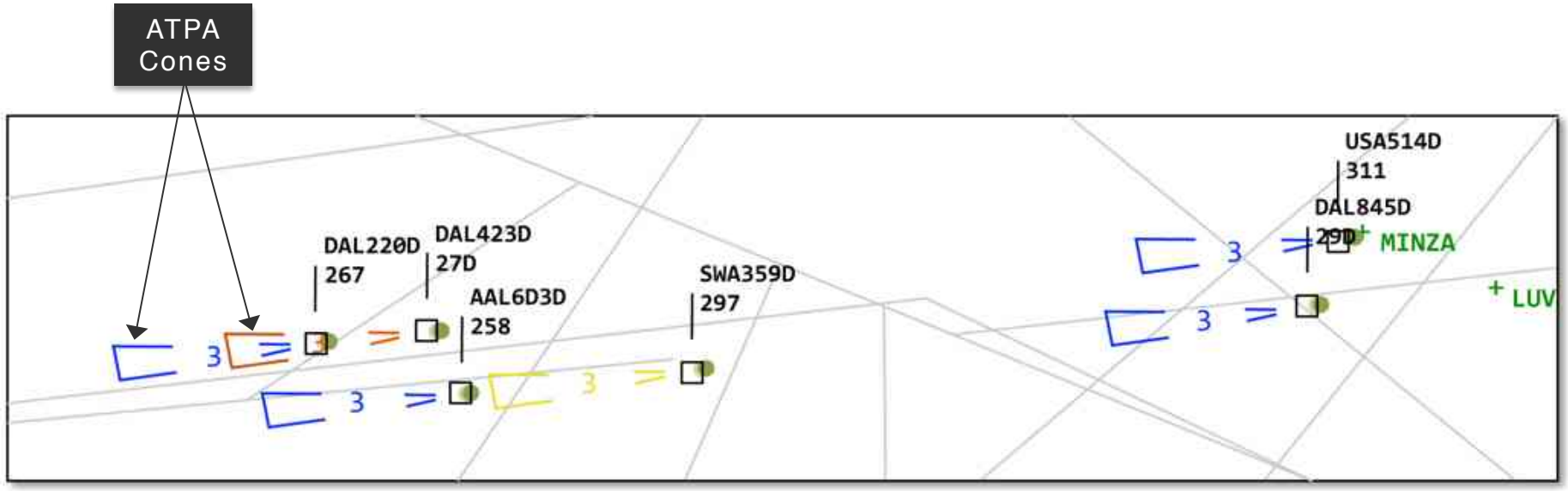
Conflict Alert

- Conflict Alert is our adaptation to the one used in the field
- No audio alerts
- CA will be turned off when ATPA is turned on



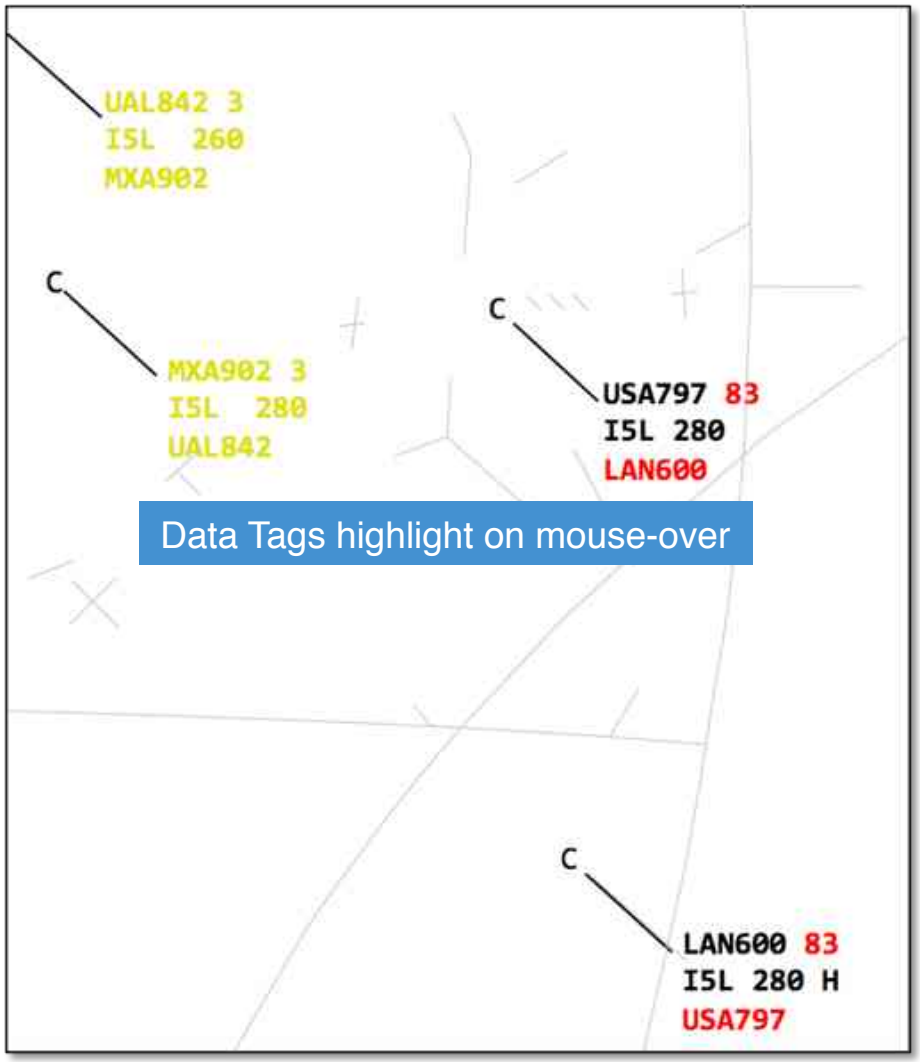
Automated Terminal Proximity Alert

- Final approach tool
- Similar to the cones of TPA on the final approach
- The graphic cones depict the following:
  - Monitor Line (blue) (means no LOS)
  - Warning Line (yellow) (45 seconds look-ahead time to LOS)
  - Alert Line (orange) (24 seconds look-ahead time to LOS)



T-TSAFE Interfaces

Data Tags



T-TSAFE Conflict Table

TTSAFE Conflict Pairs Table

CONFLICT PAIR		LOS TIME
USA5140	KAL7570	62
DAL2200	DAL4230	62
DAL4230	SWA3590	77
AAL1530	USA5140	152
AAL1530	KAL7570	167

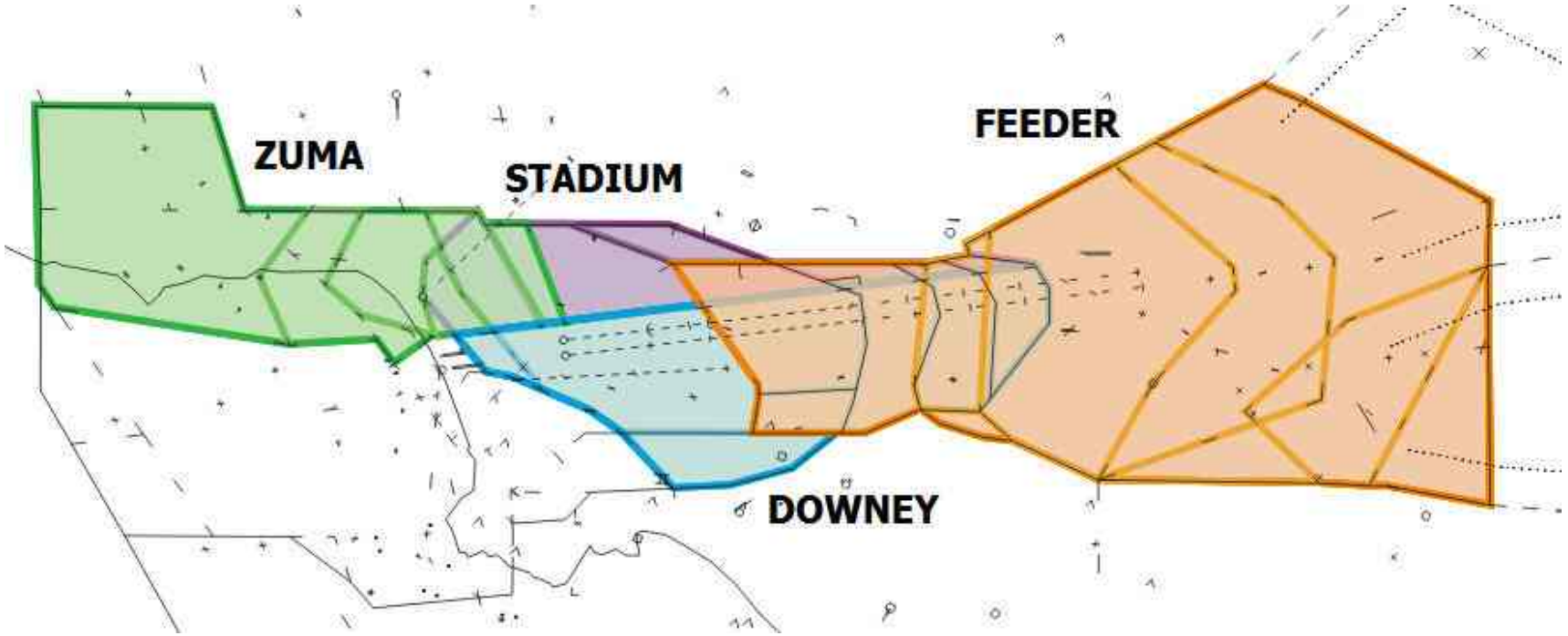
Research Questions

- Are conflicts better detected and solved by controllers in the T-TSAFE condition over Baseline (Conflict Alert)?
- How does altitude entry affect?
  - Number of losses of separation (LOS)
  - Number of false alerts
  - Time to potential loss of separation
  - Time when conflict is solved
  - T-TSAFE conflict detection ability
  - Vertical and horizontal distance between aircraft when conflict is solved
  - Workload, situation awareness, and trust in automation

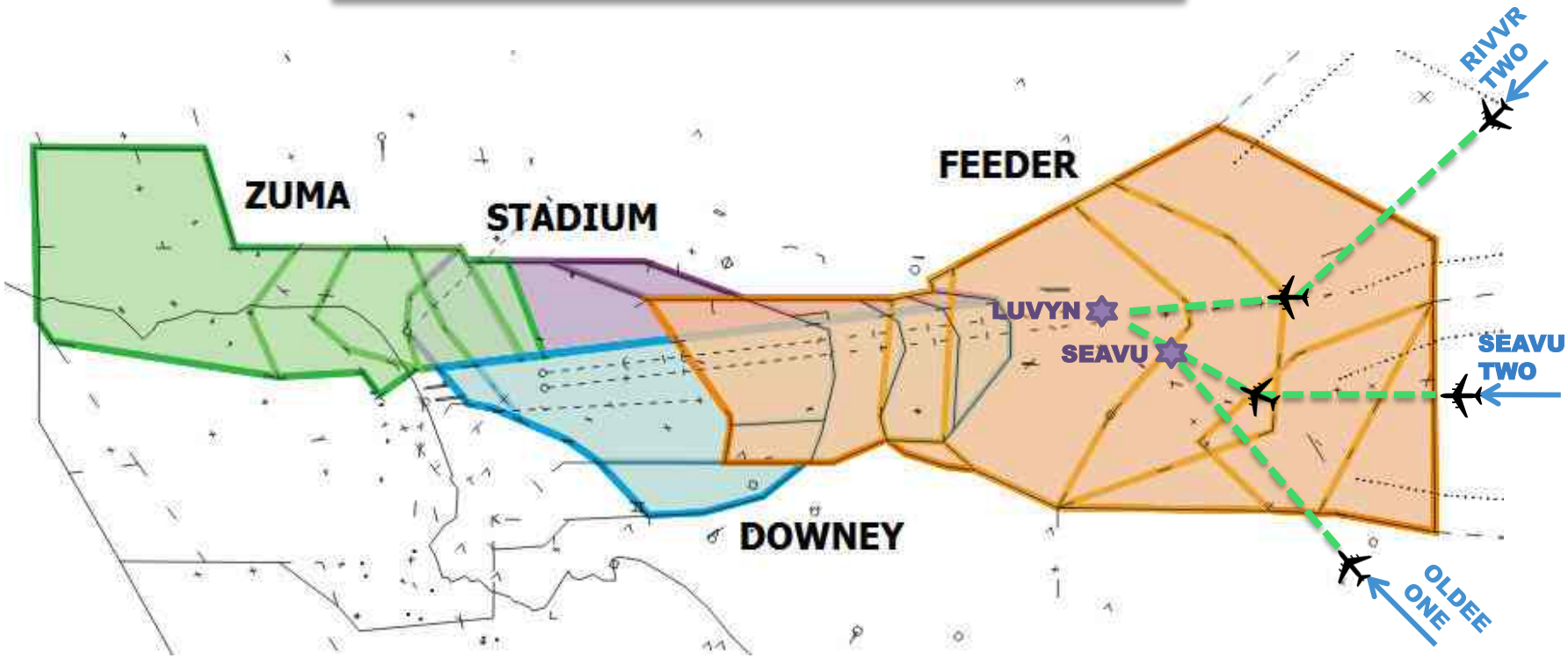
Airspace Details

- Los Angeles International Airport (LAX)
- ILS simultaneous approaches (24R and 25L)
- Airport arrival rate of 68
- Controller Positions
  - Stadium and Downey (2 approach controllers)
  - East feeder and Zuma (2 feeder controllers)
- Departures scripted
- Six arrival routes simulated VFR traffic included

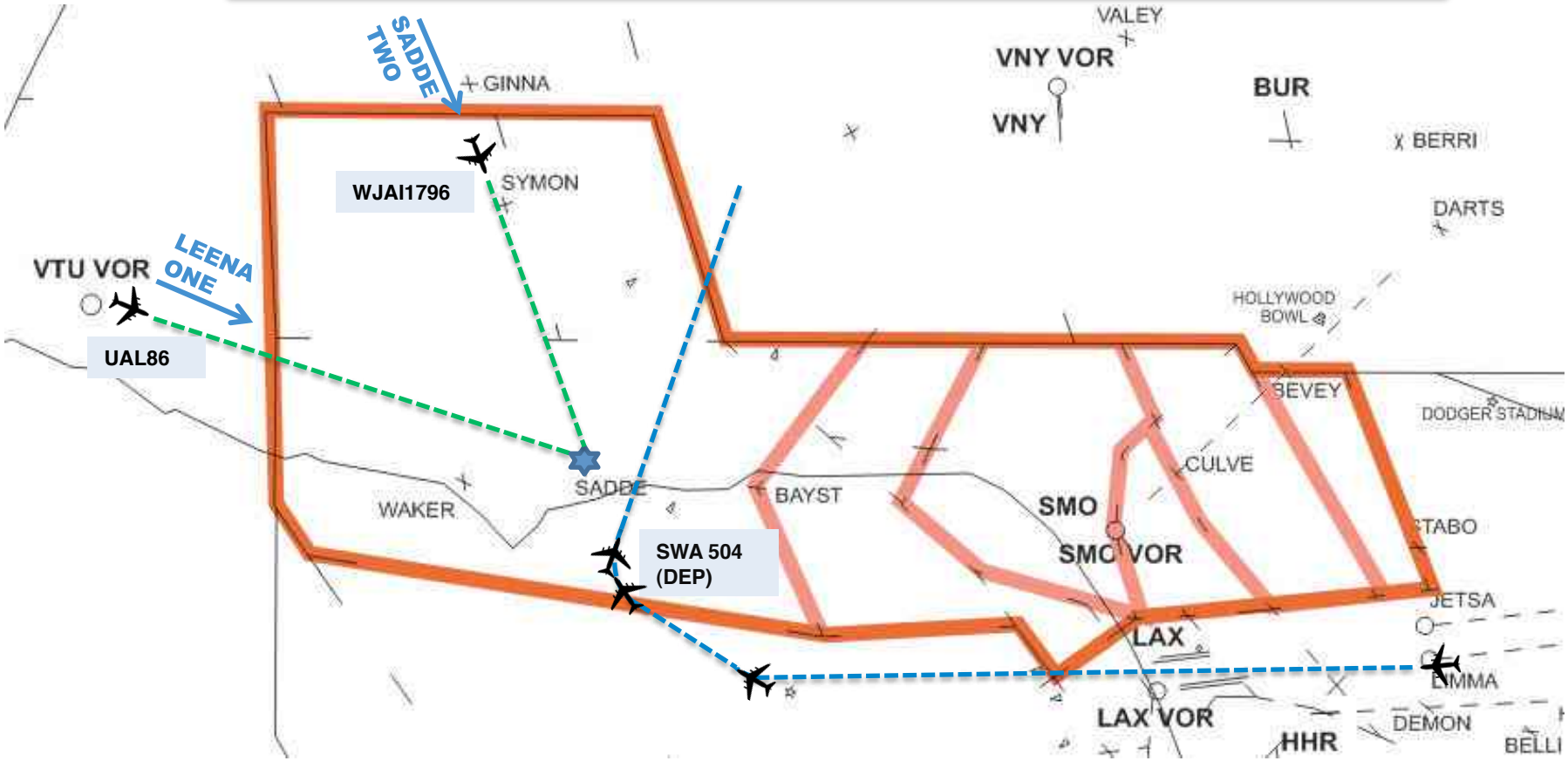
Airspace (LAX)



East Feeder Conflict: 2-way (@ Seavu) followed by 3-way (@ Luvyn) conflict



Zuma Conflict:
2-way (@ Sadde + Compression afterwards) followed by possible 3-way conflict with Casta Departure



Experimental Plan

- 4 controllers per week for two weeks
- 8 pseudo-pilots
- 4 confederates
- 4 scenarios
- 16 total runs
- 2 days of training, 3 days of data collection

Summary

- First HITL to test Terminal TSAFE using current day operations
- Controller procedures and information requirements for the tool will be identified
- Next Steps
  - HITL test to include conflict resolution
  - Integrate flight deck with the ground tool

Thank You!

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References

- Tang, H., Robinson, J., and Denery, D., “Tactical Conflict Detection in Terminal Airspace,” 10th AIAA Aviation Technology, Integration, and Operations (ATIO) Conference, Fort Worth, TX, 13-15 Sep. 2010.
- Erzberger, H. and Paielli, R.A., “Concept for Next Generation Air Traffic Control System,” Air Traffic Control Quarterly, Vol. 10(4)(2002), pp 355-378.