

**Session 35-GNC-21:
“Innovations and Support of the
NAS at the FAA”**

**Paper AIAA-2007-6519:
“Analysis of Handoffs for
Future En Route
Automation”**

Presented to: AIAA GNC, Hilton Head, S.C.

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Federal Aviation
Administration



Overview

- **Introduction**

- W. Clifton Baldwin, CSEP
- Jessica E. Rhodes

- **Study**

- Handoff Events
- Flight Example
- Potential Automation Approaches

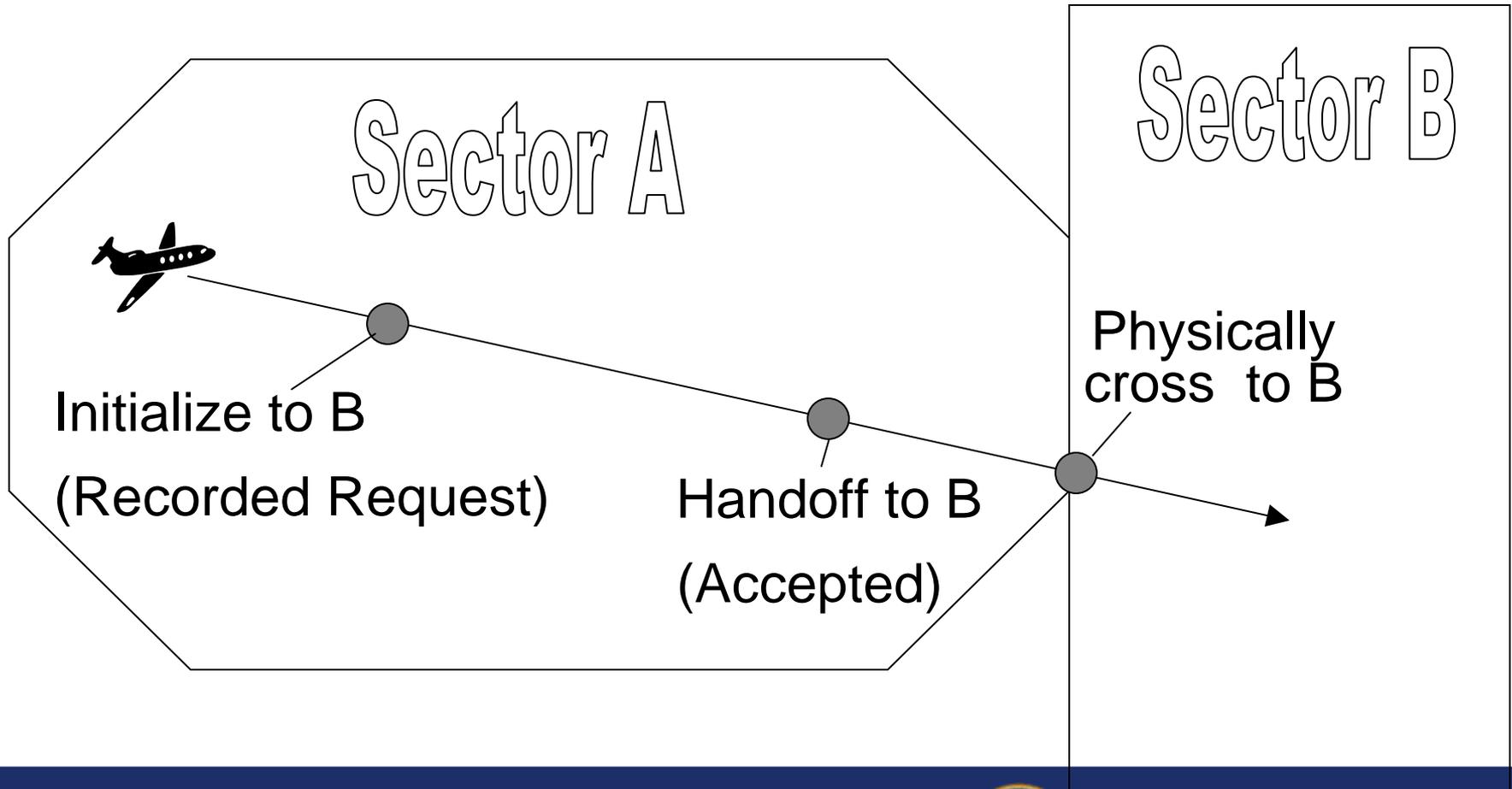
- **Results**

- **Conclusion**

Introduction

- **En Route Automation Modernization (ERAM)**
 - Automation Metrics Test Working Group
- **Flight Data Processor-related metrics**
 - This study related to a question regarding automating the initialization of handoff between sectors

Initialization of Handoff



The Study

- **Handoff Events**

- Initialization of Handoff (request) currently manual
- Handoff (acceptance) required to be manual
- Can initialization be automated to reduce controller workload?

- **Auto-Init metrics**

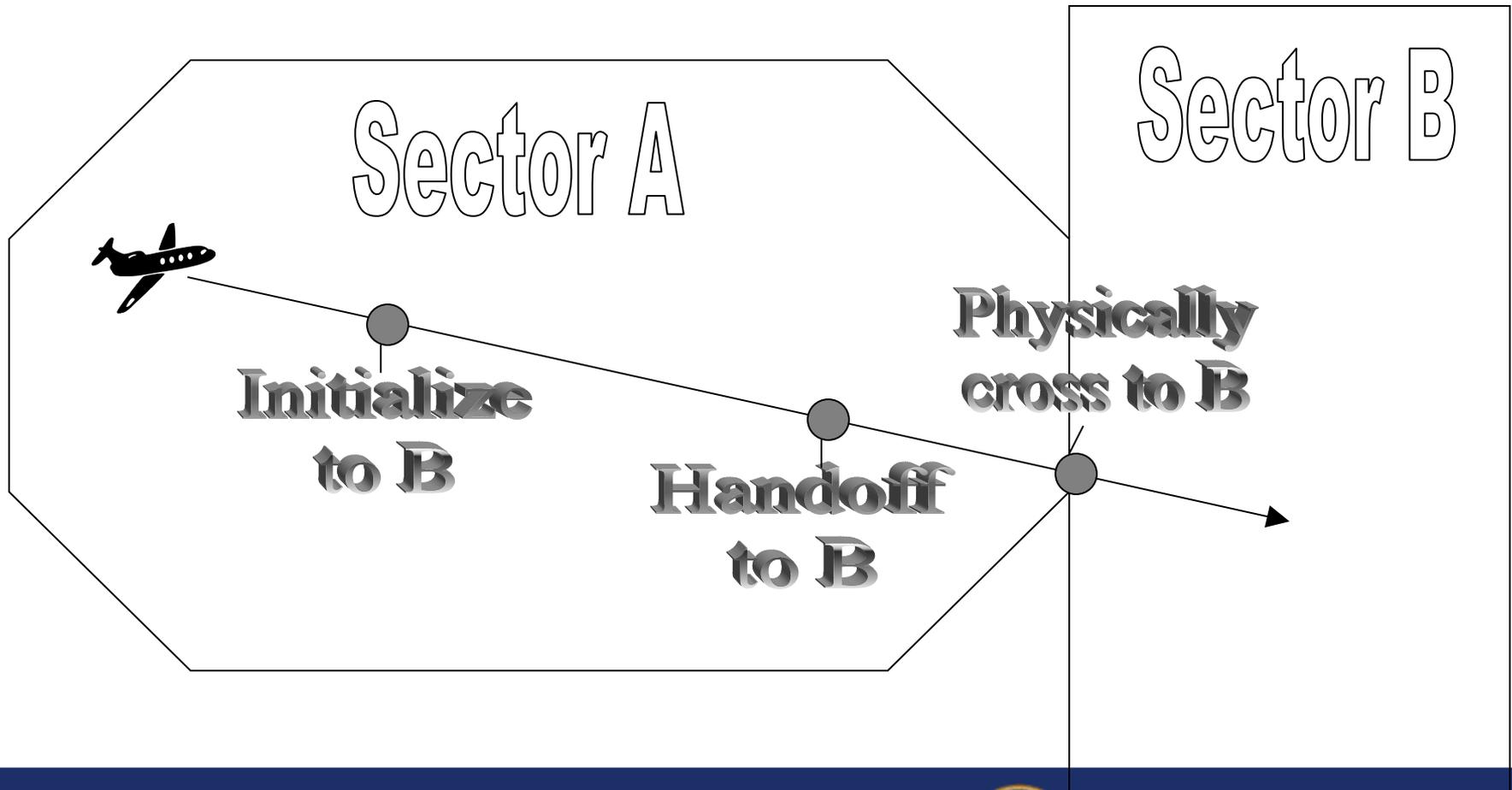
- Prediction of next sector to initialize handoff
- When should the Init (request) occur
- Accuracy of predictions at time of Init



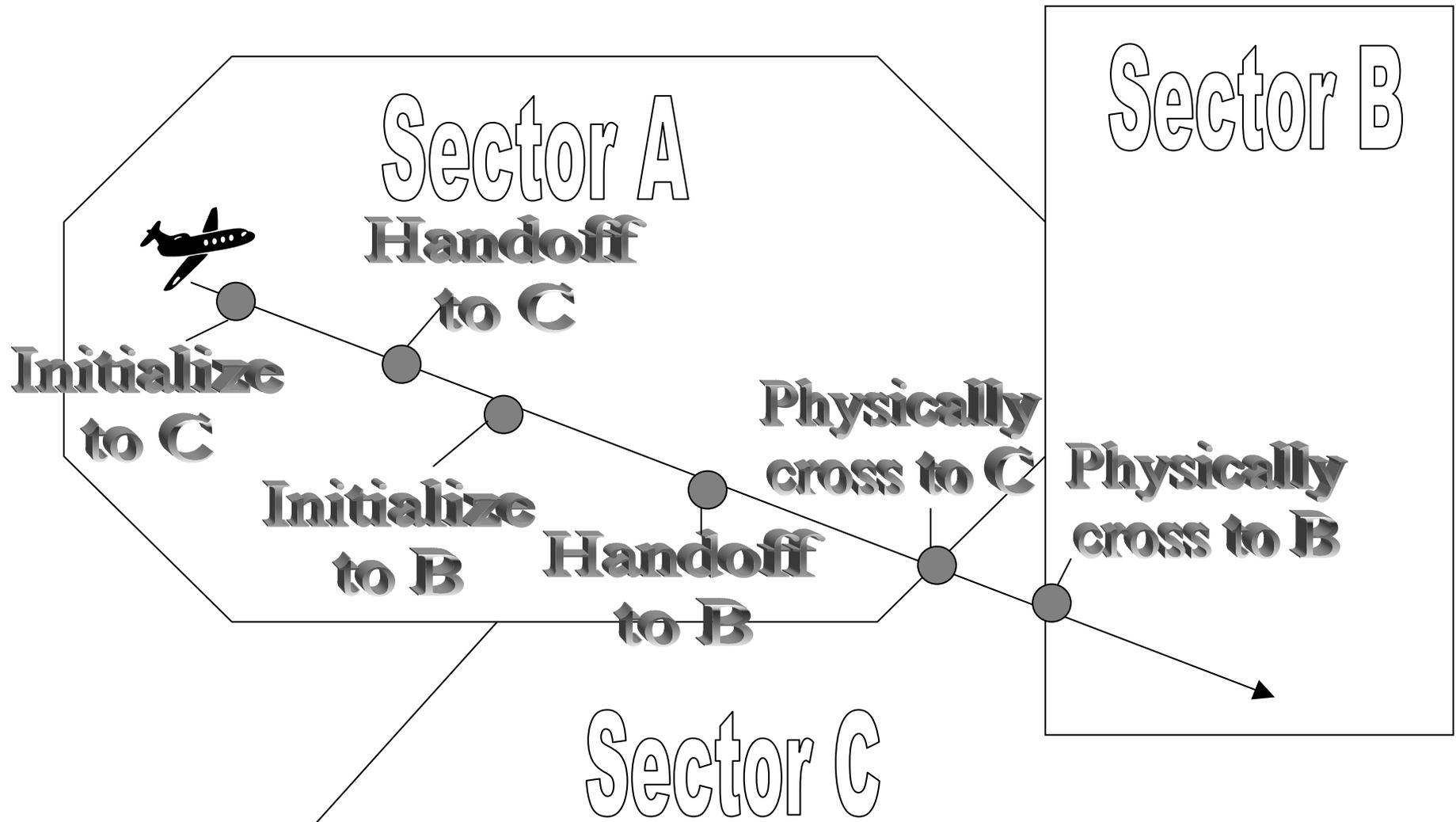
Data Set

- **Actual flight data taken from Washington Center on March 17, 2005**
 - 7,674 potential controlling sector changes found
 - Included 230 incomplete observations and unidentifiable boundaries
- **Data was analyzed to examine Initialization and Handoff events**
 - 7,444 sector changes could be identified
 - 5 types of events (517 observations) were rejected
 - 6,927 valid crossing events in final dataset
 - 6 types of events could be analyzed

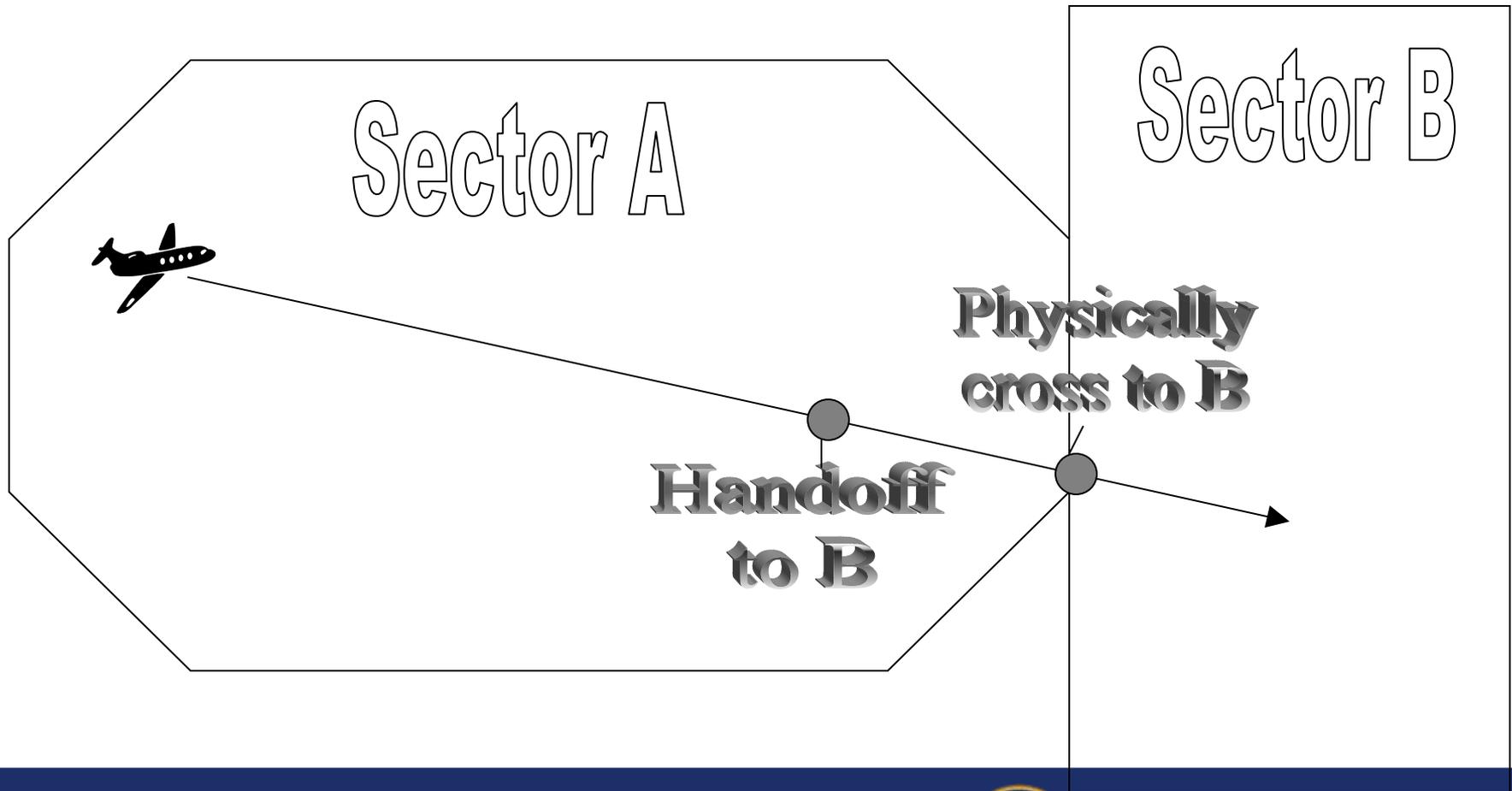
Ideal Handoff Event



Look Ahead Event (Acceptable)



No Init Event (Discarded)



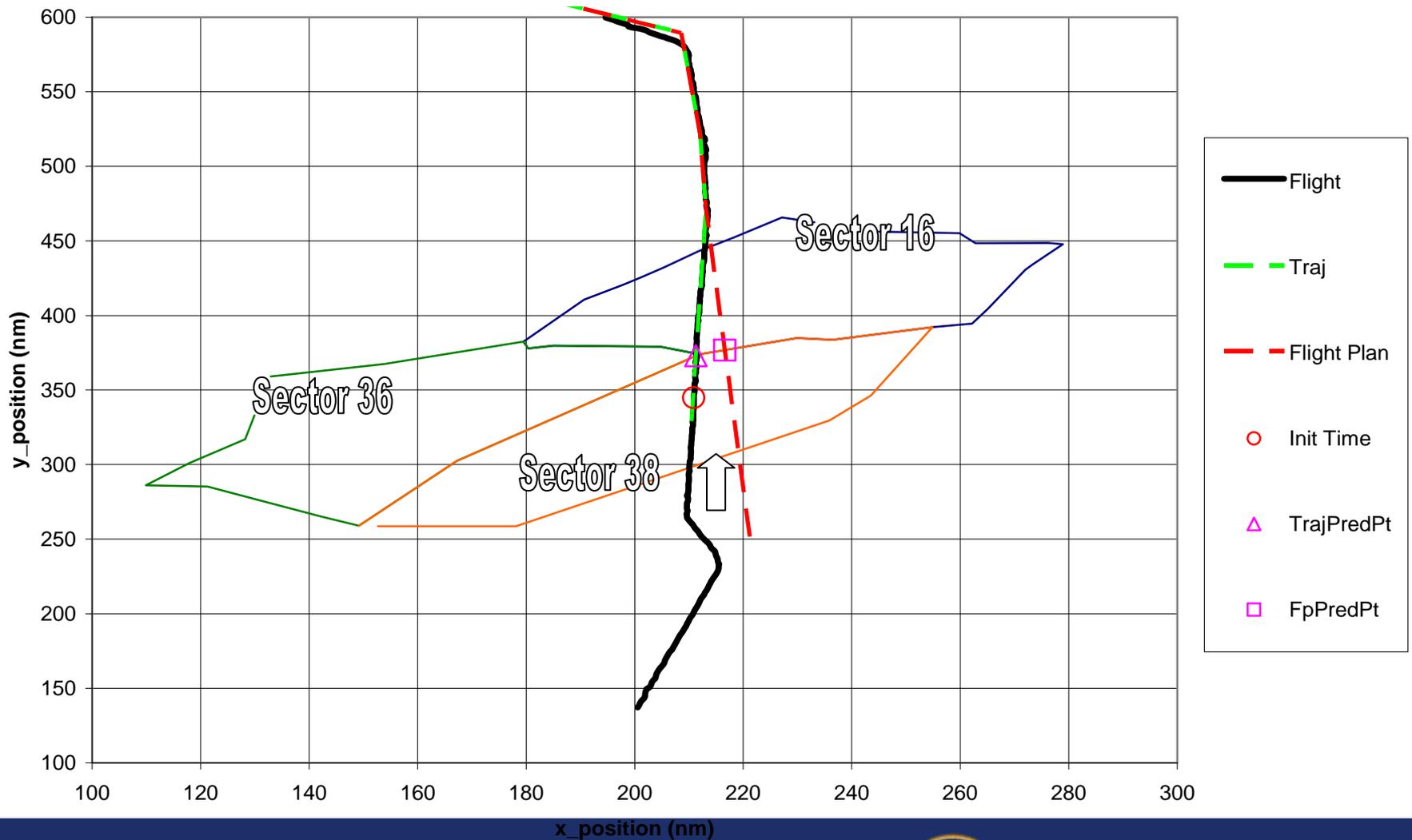
Sector Crossing Events

	Count	Percent
Acceptable	6,927	93.0%
Discarded	517	7.0%

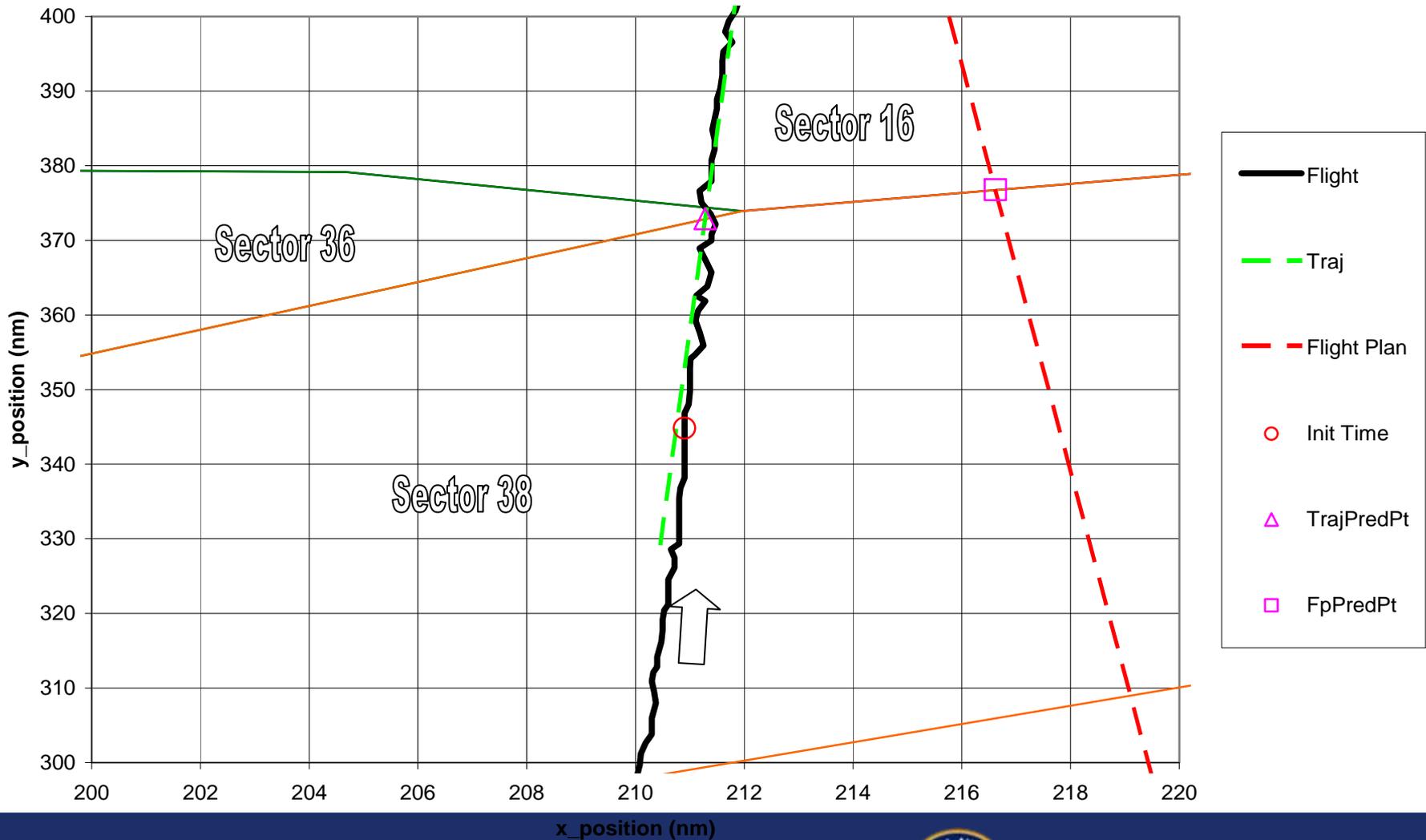
Flight Example

- **Jet flying from Florida to Ohio**
- **Control is handed off from sector 38 to sector 16**
- **Point-out event where flight briefly enters sector 36 before entering sector 16**
- **Trajectory prediction is incorrect**

Flight Example



Flight Example





Prediction of Next Sector

- **Converted route (flight plan) from existing air traffic Decision Support Tool (URET)**
- **Aircraft's 4-dimensional trajectory**
- **Therefore, Flight Plan vs. Trajectory**



Determination of Initialization

- **Operational point of initialization**
- **Set distance threshold for initialization**
 - Speed of aircraft resulted in different initialization times
 - Observations were categorized by engine type
 - Jets (34.5 nm)
 - Turboprops (23.5 nm)
 - Piston (20.0 nm)

Prediction Results

Operational

	Count	Percent
Flight Plan	3,599	64.9%
Trajectory	3,948	71.2%

Operational

	Trajectory Miss	Trajectory Predicted
Flight Plan Miss	25.5%	9.5%
Flight Plan Predicted	3.2%	61.7%

Predicted Distance

	Count	Percent
Flight Plan	4,059	73.7%
Trajectory	4,339	78.5%

Predicted Distance

	Trajectory Miss	Trajectory Predicted
Flight Plan Miss	15.7%	8.6%
Flight Plan Predicted	5.4%	70.3%

Conclusions

- **Flight Plan prediction versus 4-D Aircraft Trajectory prediction**
- **Operational point of initialization versus set distance point of initialization**
- **93% of sample events were valid**
- **Highest prediction rate**
 - 4-D Trajectory
 - Set distance
 - 78.5% success
 - Therefore 73% accurate across all sample events

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