Analysis of Taxi Conformance Monitoring Algorithms and Performance

Chris Brinton

Dr. Steve Atkins

Abraham Hall

Mosaic ATM, Inc.

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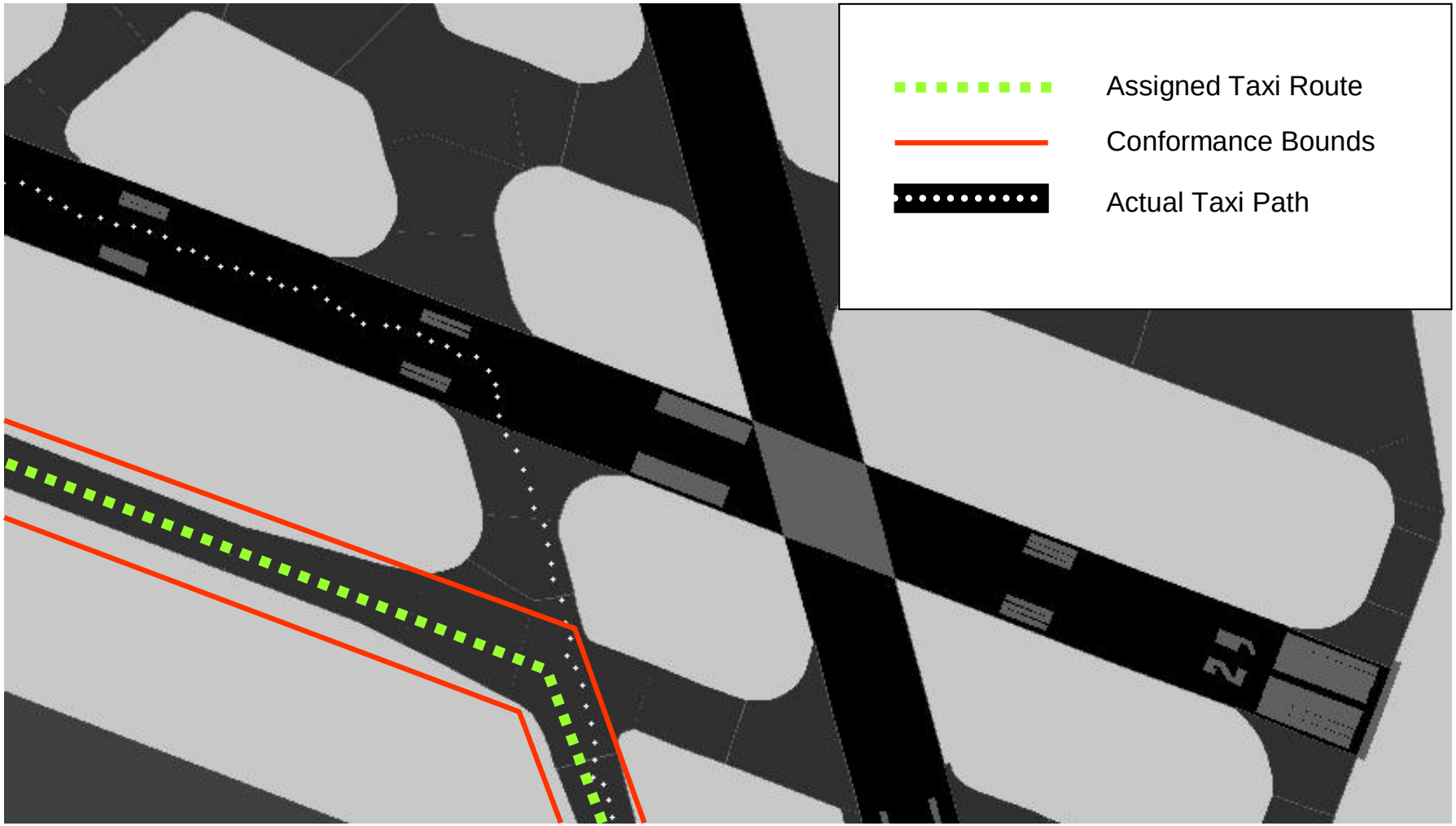
Presentation Outline

- Taxi Conformance Monitoring Overview
- Operational Requirements Issues
- Analysis Approach
- Results
- Conclusions and Future Work

Taxi Conformance Monitoring Overview

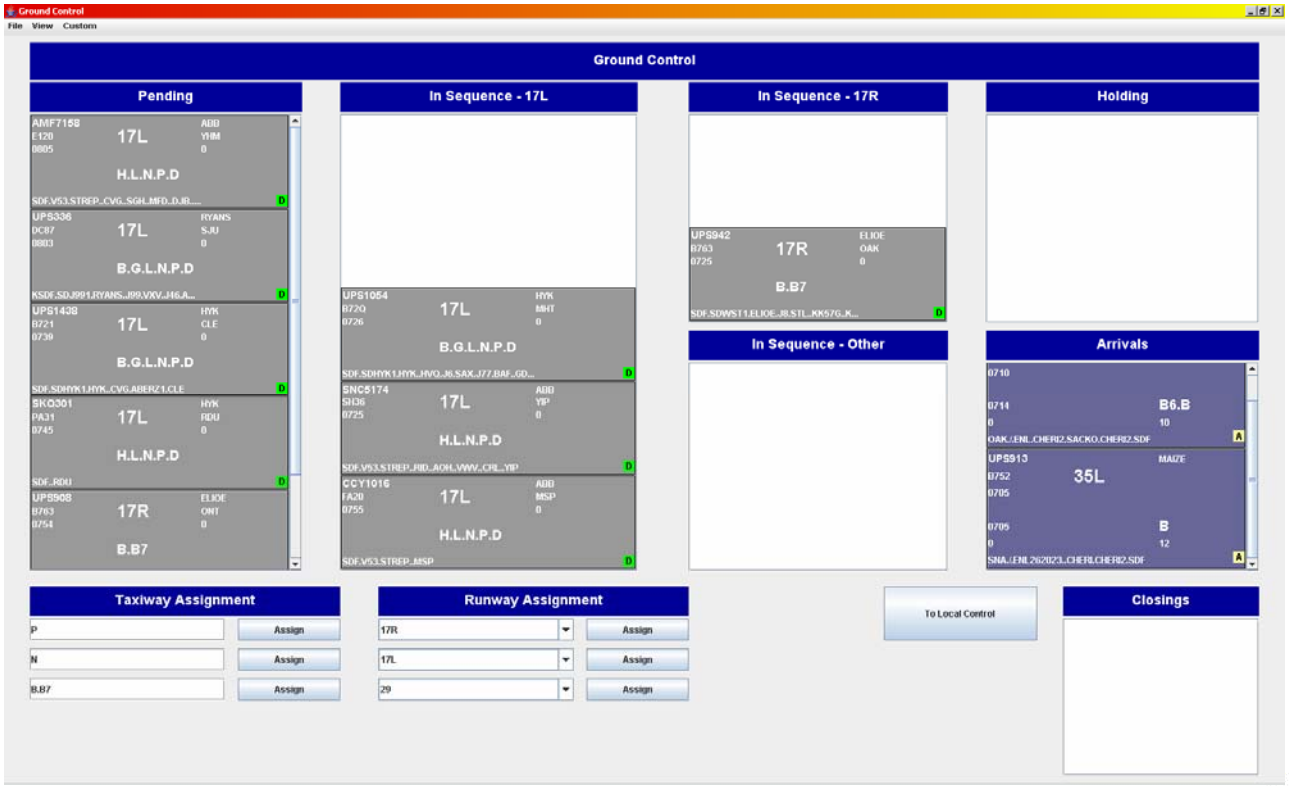


Taxi Conformance Monitoring Issues

- Hardest Part: Getting the Assigned Taxi Route for Monitoring
- Assigned Taxi Route Must Be Accurate
  - To Avoid False Alerts
- Controller Workload to Specify Taxi Route Must Be Low
  - To Ensure Acceptance
  - To Ensure that Situational Awareness and Safety are Improved

Taxi Route Management

- Proposed Approach: Full Taxi Route Management Capability
  - Integrated with Surface Surveillance
  - Integrated with Electronic Flight Strips for Tower



Operational Issues

1. Should the automation require the controller to confirm the taxi route before initiating conformance monitoring?

2. Can technology and procedures be established to allow taxi sequence and hold short instructions to be monitored?

3. Can taxi clearances be issued exclusively via data link?

4. What are the taxi route data link interface requirements?
   - How can ATC and Aircraft maps of airport be synchronized?

Analysis Questions

- Question 1: How Accurately Can Taxi Routes Be Predicted?
  - If Taxi Route Prediction Accuracy is High
    - Then Controller Workload to Enter or Correct Taxi Routes Will Be Lower
- Question 2: How Soon is a Taxi Deviation Alerted?
  - How Much Distance is Traveled by the Aircraft Before the Alert?
    - Can the Alert Keep the Aircraft Away from the Runway?
- Question 3: What is the Rate of False Alerts? And Missed Alerts?
  - False Alerts Reduce Acceptance of the System
    - Lack of Trust of Alert Reduces Pro-Active Response Likelihood and Response Time
  - Missed Alerts Reduce Acceptance and Trust in the System
    - And Decrease Safety

Analysis Approach

- Prototype Algorithms Implemented in the Surface Decision Support System:
  - Taxi Route Prediction
  - Taxi Route Conformance Monitoring

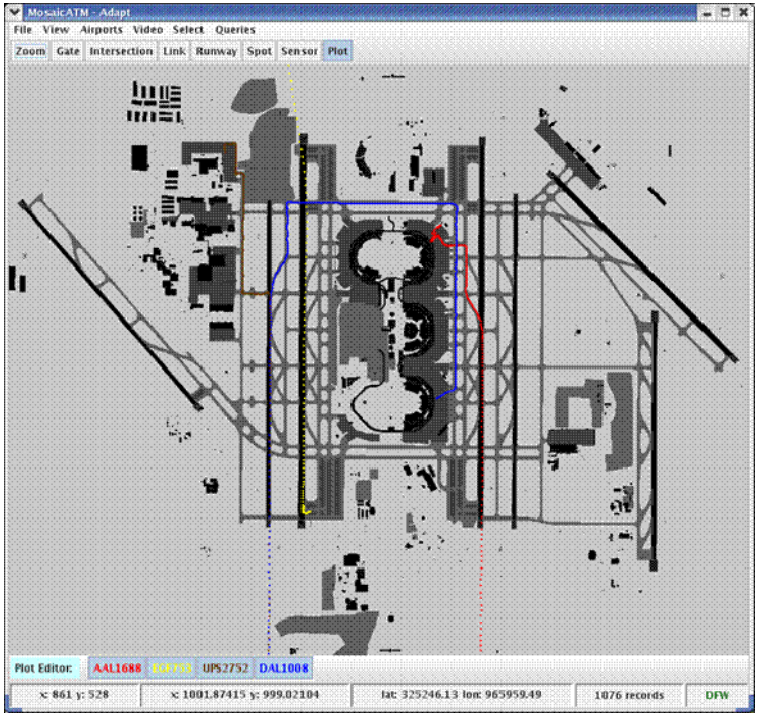
- Flight Plan and Surface Surveillance Data from Louisville, Kentucky
  - For Two Departure Push Periods

- Over 125 Flights Considered
  - Only Flights with Correct Runway Assignments During the Entire Departure Phase of Flight Considered
  - 80 Flights Included in Analysis

- Manual Analysis Used to Measure Distance Between Deviation and Alert

Analysis Approach (cont.)

- Surface Operations Data Analysis and Adaptation (SODAA)
  - On-line data warehouse to simplify surface data access
  - Data Mining tools to identify Controller decisions and strategies, airport surface choke points, sequencing methods and factors
  - Extraction of Expert System Knowledge Base from data
  - Support for Adaptation creation and modification



Results

- Question 1: How Accurately Can Taxi Routes Be Predicted?

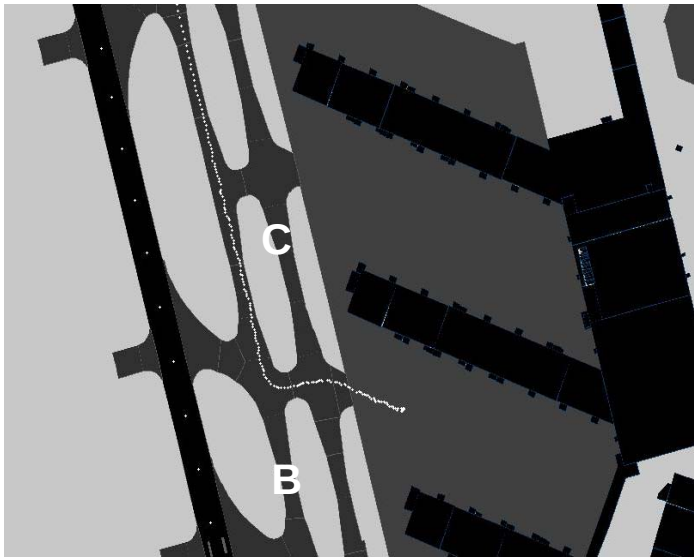
	Correct No Alert	Correct Alert	False Alert	Missed Alert
Count	45	32	3	0
Percentage	56.25%	40.00%	3.75%	0.00%

- Taxi Routes Predicted Correctly for Over 56% of the Flights
  - Without Performance Improvement Modifications

Taxi Route Prediction

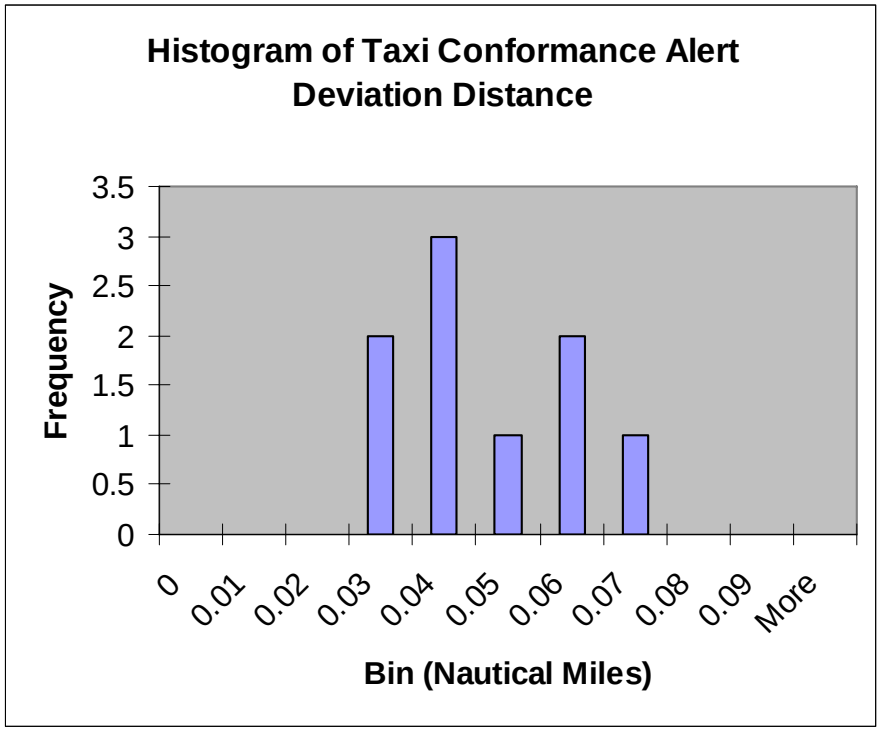
- Encoding Standard Taxi Procedures will Improve Accuracy

Predicted Route	Actual Route	Occurrences
C.F.B	B	15
B.G.L.N.D	C.G.D	7
B.G.L.N.D	C.F.D	2
B.G.L.N.D	D	2
B.G.L.N.D	B.F.D	1
B.G.N.D	B.11.N.D	1
C.F.B	C.B6.B	1
C.F.B.G.L.N.D	C.F.D	1
C.F.B.G.N.D	C.11.N.D	1
D.F.B	D.29.B	1



Taxi Conformance Performance

- Question 2: How Soon is a Taxi Deviation Alerted?
- Results Shown Represent a Random Subset of the Data



False and Missed Alert Rate

- Question 3: What is the Rate of False Alerts? And Missed Alerts?

	Correct No Alert	Correct Alert	False Alert	Missed Alert
Count	45	32	3	0
Percentage	56.25%	40.00%	3.75%	0.00%

- A Trade-Off Exists between
  - Deviation Distance Required for Alert, and
  - False Alert Rate

- The tighter the threshold for taxi deviation, the more likely that minor navigation and surveillance errors will trigger a false alert

Conclusions

- Taxi Conformance Monitoring Requires Accurate and Timely Assigned Taxi Route Data
  - Potential Controller Workload Impact
  - Use Surface Decision Support System to Mitigate Workload Impact
    - Taxi Route Prediction
    - Taxi Management Tools

- Significant Potential Benefits for Airport Surface Operations
  - Increased Safety
  - Reduced Workload

- Recommendations and Future Work:
  - Evaluate Integration of Taxi Management Tools with Tower Electronic Flight Strip System