Trajectory and Queue Management   TQM

Rapporteur: Sandy Lozito, NASA Ames

Session Chair: Will Johnson, FAA

Papers

The Trajectory and Queue Management (TQM) Theme was a new paper/presentation theme for the ATM conference. Clearly, the management of trajectories and queues is directly relevant to trajectory-based operations, a core element to both NextGen and SESAR concepts of operation. In general, the papers in these sessions discussed the ability to identify, mitigate, quantify, and predict trajectory errors. In addition, trajectory flexibility and the application of queue management were explored.

There were five Trajectory and Queue Management Papers:

Paper 38: Use of Linear Aircraft Intent Response for Tactical Trajectory Based Operations, presented by Stephane Mondoloni, Mitre. This paper discusses a method proposed for exchanging information that allows a ground system to estimate the aircraft intent response to a ground instruction. The approach is described and applied to the case of an aircraft in climb subject to a controlled time-of-arrival.

Paper 141: Lateral Intent Error's Impact on Aircraft Prediction, presented by Mike Paglione, FAA. The paper reports on a study that examines the lateral deviations from the automation's known horizontal route of flight to the actual aircraft position. Analysis illustrated the direct impact these errors have on safety critical separation management functions

Paper 30: Departure Scheduling in a Multi-Airport System, presented by Yanjun Wang, Nanjing University. This paper discusses the scheduling problems for multi-airport departure flights. A mathematical model is presented for sequencing departure flights in different airports within one terminal area.

Paper 101: Distributed Trajectory Flexibility Preservation for Traffic Complexity Mitigation, presented by Husni Idris, L-3 Communications. In this paper, the authors propose the introduction of decision-making metrics for preserving user trajectory flexibility The impact of using these metrics on traffic complexity is investigated.

Paper 151: Application of Queueing Models to Assess the Impact of 4-D Trajectory Precision, presented Tasos Nikoleris, University of California. The potential benefit from introducing trajectory based operations into the NAS is estimated in this paper. Delay predictions of a stochastic and a deterministic queuing model, which represent high and low levels of trajectory uncertainty, are compared.

Analysis

The maturity level of research suggests that the ATM community has some excellent data and analytic tools for measuring and assessing trajectory parameters. Because of the critical nature of this work due to the dependence upon trajectory-based operations within SESAR and NextGen, the maturity level of the mathematical and operational methods seems to be developing fairly rapidly. These research efforts include the use of stochastic and deterministic queuing models, and the representation of different levels of uncertainty.

Modeling and algorithm development continues to mature, and these methods have clearly created an ability to evaluate the types and amount of data necessary for trajectory and queue management research. As these techniques continue to improve, allowing for techniques such as more stochastic modeling and consideration of uncertainty parameters, the research will offer even more insight into trajectory-based operations and its critical issues.

An issue shared by European and U.S. research communities regarding TQM involves the difficulties of incorporating weather phenomenon when measuring and predicting trajectories. In addition, access to more data from more organizations, including airlines, would assist in obtaining more representative data and results.

General Aspects

- There was one joint paper that involved authors from Australia, Europe, and the US, three papers from the US, and one paper written and presented by authors from China.

- Approximately 25-30 Seminar participants attended the two sessions on Wednesday afternoon.

- The overall quality of papers was quite high. The use of sophisticated and mature mathematical methods was emphasized.

High-level Recommendations

- The impact of various weather phenomenon, including winds, need to be further explored when considering the impacts of trajectory determination and prediction.

- There is a need to obtain and coordinate integrated air and ground data and performance in order to insure trajectory-based operation prediction and compliance.

- Departure scheduling research in regions where there are multiple airports is necessary for the SESAR and NextGen Concept of Operations. The inclusion of airline data would provide important benefits to that research.

- More work needs to be done to address the vertical dimension of trajectories to evaluate errors and develop predictive capabilities

Issues to address for future seminars

- The joint implications for the aircraft and ground systems when measuring and predicting trajectory operations need to be determined.
- Integrated arrival and departure data will improve airport scheduling techniques

Research gaps, divergences and needs

- Issues when incorporating the weather affects (including winds) for TQM
- Broader access to a variety of data to allow for more thorough assessment of trajectory and queue parameters.
- Inclusion of airline data and preferences
- Explorations in vertical parameters of trajectory-based operations
- Issues associated with sharing trajectories across systems, including the following considerations:
  - How should we define/represent trajectories from a system perspective?
  - Are the current standards for trajectory representation sufficient? What is missing from the standards?
  - Will the fidelity of trajectory information vary between systems? How/why?
  - How much trajectory intent is sufficient for a given application?
  - Which system manages the trajectory and do management roles change as the aircraft progresses through systems?