

Air Ground Integration



Session Report

Rapporteur: Eric Hoffman

Session Chair: Bob Graham

Session Chair: Will Johnson

AGI: Background



- 19 papers submitted for AGI, 4DT or SUR as principal “theme”
- 5 additional papers identified as relevant
- 8 selected – 6 US and 2 EUR
- 2001 – Santa Fe: 11 papers
- 2003 – Budapest : 14 papers
- 2005 – Baltimore : 8 papers

Air Ground Integration: Agenda



- Evaluation / Benchmarking of Components:
 - Conflict Resolution
 - Trajectory Prediction
- Overall Concept Performance Assessment
 - Automation tools and reducing controller workload
 - Spacing and Separation, both airborne and ground based
 - Tools and concepts for NextGen/SESAR, midterm, and short term
- Human in the loop evaluations:
 - From ground to flight deck focus
- **Trajectories management** recurring them in papers

AGI: Wednesday Morning



– 4 Papers

- 173: Fast time simulation of a conflict resolution algorithm under high air traffic demand
- 116: Performance based Air Traffic Management – Evaluating Operational Concept Acceptability
- 147: Arrival Management with required navigation performance and 3D paths
- 112: Merging arrival flows without heading instructions

Fast time simulation of a conflict resolution algorithm under high air traffic demand (173)



- Automated **conflict resolution algorithm**
- Resolves detected conflicts 1 – 20 minutes from first loss of separation
- Rules base on manoeuvre – climb/descent, path stretch, speed
- Simulated departure, en-route and arrival
- Assumes **4D trajectories** for all aircraft
- Results show capable of resolving conflicts safely at higher traffic levels than today. **Maturity of algorithms**
- **Assessment protocol / benchmark**

Fast time simulation of a conflict resolution algorithm under high air traffic demand (173)



– Seminar Comments:

- Coverage of criteria/metrics for benchmarks
- Controller actions to be removed from radar data
- How to grow traffic? **Possible research topic in itself.** How exactly do we model future traffic scenarios as accurately as possible?
- Requirements for local adaptation / tuning?

- Need for agreement of benchmarking criteria!

**Performance based Air Traffic Management –
Evaluating Operational Concept Acceptability
(116)**



- **Midterm concept** for 2018
- System wide availability of consistent and up to date flight and traffic flow information
- Air ground data exchange for clearances, data and weather
- **4D trajectory shared amongst all users**
- RNAV & RNP
- **Automation for conflict detection, & resolution**
- Structured airspace design
- Cockpit automation to improve flying accuracy
- Probabilistic TFM to reduce congestion risk
- Time based arrival metering
- Results show reduced time on routine & complex tasks
- Increased traffic handled and efficiency gains
- Heavily dependent on datalink implementation

**Performance based Air Traffic Management –
Evaluating Operational Concept Acceptability
(116)**



– Seminar Comments:

- Human cannot take over any more / Handling of exceptions?
The traffic state can be too complicated for human cognitive ability to handle while maintaining safe operations.
- Performance metrics vs. workload assessment
- Uncertainties – to be modelled for realism
- Responsibility: who and when? Traditionally, the controller is responsible for separation. But the controller is not given enough information to ensure separation. The separation task is performed by the automation. Are we comfortable with making automation responsible for separation?

Arrival Management with required navigation performance and 3D paths (147)



- **Trajectory based operations in the near term**
- Integrate FMS, RNP and ground based tools to increase airport and airspace capacity
- Near term enabled through voice comm
- Fast time model shows classical influences on delivery of wind, TP and navigation accuracy
- Step to NextGen but needs **good met forecasting** and trajectory prediction
- 2nm or 25 seconds spacing buffer at the meter fix covers trajectory error – but costs an additional 90 seconds of arrival delay for each flight
- Result is also new model for supporting trade studies on **trajectory performance parameters** through arrival phase

Arrival Management with required navigation performance and 3D paths (147)



- Seminar Comments:
 - Reducing uncertainties:
 - Met/Wind forecast – downloading information, sharing
 - RTA: closing the loop to improve performance
 - Exceptions: how to intervene, make room for unexpected things?

Merging arrival flows without heading instructions (112)



- Sequence aircraft on a point with conventional direct to instructions on predefined legs – **new route structure**
- **Increased predictability** under high traffic load, accurate spacing and improved descent profiles (CDA from FL100)
- Orderly traffic flows with aircraft remaining on FMS and **closed loop trajectory**; more accurate final approach spacing.
- Safety, environment and efficiency benefits
- Reduced controller workload
- Requires only P-RNAV capability
- Prepares for airborne spacing and transition towards P-RNAV plus CDA and use of RTA.

Merging arrival flows without heading instructions (112)



- Seminar Comments:
 - Uncertainties:
 - Pilot reaction time
 - Extending... how to perform CDA from T/D?
 - Traffic patterns/ route structures: learning from traffic engineering to create capacity

AGI: Wednesday Afternoon



– 4 Papers

- 158: Air/Ground simulation of trajectory-oriented operations with limited delegation
- 105: Propagation of Airborne spacing errors in merging traffic streams
- 153: Evaluation of a flight deck-based merging and spacing concept on en-route air traffic control operations
- 127: Application of key performance indicators for trajectory prediction accuracy

Air/Ground simulation of trajectory-oriented operations with limited delegation (158)



- **Merging and Spacing experiment** in Louisville
- Combination of trajectory operations and ASAS
- Airborne spacing using Eurocontrol CoSpace algorithm
- Spacing has clear benefits but also has energy management concerns
- Automated arrival management was very effective
- ATC Tools were developed that reduced controller workload

Air/Ground simulation of trajectory-oriented operations with limited delegation (158)



– Seminar Comments:

- Thought to be impossible 10 years ago... soon to be in operation with UPS
- How to extend it to other environments? To mixed airlines?
- Source of uncertainties
- Complementary & overlapping benefits of Concept Elements (AMAN/ASAS/ATC Tools)

Propagation of Airborne spacing errors in merging traffic streams (105)



- Airborne spacing wave compression can be avoided by looking at a history of preceding aircraft
- In manual mode, speed variation cost needs to be reviewed further

Propagation of Airborne spacing errors in merging traffic streams (105)



- Seminar comments:
 - Required information
 - Influence of ADS-B Surveillance
 - ADS-B model assumed perfect performance. Additional work was performed after paper to examine results with ADS-B dropouts.

Evaluation of a flight deck-based merging and spacing concept on en-route air traffic control operations (153)



- Demonstration of Flight Deck-Based **Merging and Spacing** (FDMS) concept
- CDTI applications reviewed including situational awareness, spacing, separation and self separation
- Reduce the need for downstream controller interventions
- Implemented using two cockpit displays, CDTI and AGD(ADS-B Guidance Display)
- US/Europe, Industry, RTCA involvement
- FDMS concept was generally acceptable to controllers, with reduced workload and reduced communications
- Further simulations conducted and analysis continues

Evaluation of a flight deck-based merging and spacing concept on en-route air traffic control operations (153)



- Seminar comments:
 - System Performance Metrics: no sufficient data
 - Tied to the UPS Louisville ADS-B activity which is being closely watched within the US for ADS-B implementation

Application of key performance indicators for trajectory prediction accuracy (127)



- Work derived from Action Plan 16
- An approach to defining quality of predicted trajectories
- May define common criteria for comparison of trajectory predictors
- Useful for exchange of trajectory data within US/Europe Flight Objects

Application of key performance indicators for trajectory prediction accuracy (127)



– Seminar comments

- Since lateral perturbations contribute less significantly to error, they were not examined in this study.
- End of a very long day!

Conclusions



- Set of papers reporting elements of larger R&D projects
- All the papers can be linked to earlier Seminars with progress reported
- Recurring Themes/Questions:
 - Common metrics / benchmarks
 - Exception handling / uncertainties