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AVIATION OPERATIONS RESEARCH

NEXTOR Research Directions in CDM

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December 10, 1998

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Outline

- NEXTOR strategy vis-a-vis CDM
- Brief overview of NEXTOR research initiatives under CDM
- Examples
  - Short-term perspective
  - Long-term perspective
- General observations

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NEXTOR strategy and objectives for CDM work

- Mixture of short- and long-term projects
- Emphasis on student research
- Great student interest; future leaders
- Mixture of empirical and methodological work
- Contribute to longer-term outlook
- Cultivate relationship with ATM users
- Cope with “time constant” issue

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Performance Monitoring and Evaluation

- Benefits analysis of initial implementation; estimation of: airborne delays; improvements in cancellation notification times; predictive accuracy of data streams. (Ball et al., 8/98)
- Refinement of Benefits Assessment.
- CDM performance metrics (with Metron).
- Economic impact of CDM.
- J. Jensen (MIT, SM, 1/99), G. Ville (ENAC, France/UMd, SM) : Enhanced data analysis to evaluate CDM GDP benefits.

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Example: Refinement of BA (Jensen)

- January 1 - September 30, 1998
- GDP incidence and cancellation statistics
- GDP impact on:
  - Ground delay - Airborne time
  - Airborne holding
  - Utilization of slots
- Hard data analysis and statistical issues
- Remarkable performance (preliminary)

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Setting AARs under Uncertainty

- Arrival acceptance rates (AAR) are fundamental to effectiveness of GDPs.
- Often set under uncertainty re. weather and demand.
- NEXTOR developed models for setting AARs that consider uncertainty and trade-offs between ground and airborne delay.
- Working on stochastic estimation of arrival demand.

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Setting AARs under Uncertainty: A Model

- R. Hoffman (UMd, PhD, 12/97): Integer programming models for ground holding in ATFM.
- R. Rifkin (MIT, SM, 1/98): Airport acceptance rates under uncertainty about airport capacity.
- Given:
  - a forecast of arrival demand for next few hours
  - a probabilistic forecast ("scenarios") of capacity
  - an indication of the approximate "trade-off rate" between airborne delay and ground delay ($R=c_a / c_g$)

suggest AAR values

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Utility of Model

- Answers quickly "what if" questions on implications of:
  - alternative scenarios
  - changes in likelihood of scenarios
  - trade-offs of ground vs. airborne delay
- Consistent with CDM viewpoint: aggregate AAR vs.delay assignment to individual flights
- Challenge of probabilistic scenarios
- "Real-time", off-line experiments needed.
- T. Innis (UMd, PhD,): Models for estimating capacity distributions for ATFM.

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TMA Decision Tools and CDM

- TMA operations may benefit greatly from combination of CDM and TMA decision tools.
- Identify critical CDM and tool-derived information and decision sequences.
- W. Hall (MIT, PhD, 5/99): Information flows and decision-making archit're in future TMA.
- A. Muharremoglu (MIT, SM, 1/99): Sequencing of arrivals and departures with user preferences.
- N. Pujet (MIT, PhD, 5/99): Modeling an Airline Operations Center's interactions with ATM.

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Improved prediction of take-off times

- R. Shumsky (Ph.D., 9/95): Dynamic prediction of take-off times
- Detailed analysis of BOS take-off operations through ASQP data, airline data, observations.
- Development of real-time dynamic models to improve prediction of take-off times.
- B. Delcaire (MIT, SM, 5/98): Taxi-Outs at BOS.
- K. Anderson (MIT, SM, 5/99): Analysis of second airport with hubbing.
- N. Pujet (MIT, Ph.D., 5/99): Dynamic models

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Collaborative Routing

- Extension of ration-by-schedule concepts to allocation of airspace resources.
- Incorporation of CDM concepts within large scale route optimization algorithms.
- J. Goodhart (UCB, PhD): Collaborative routing.
- S. Stock (MIT, PhD, 6/97): Traffic Flow Management with en route and airport capacity constraints.

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Fair Slot Allocation in a Competitive Environment

- Optimization models for time slot allocation with “fairness” objective functions
- Game theoretic analysis of CDM GDP procedures
- T. Butler (UMd, SM, 8/98): Optimization models with fairness objectives for ATM.
- T. Vossen (UMd, PhD): Optimization models for the fair allocation of time slots.

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GDPs in a CTA-based environment

- Potential feature of FFP1.
- Determination of ground-delay assignments in absence of CTDs is left to airlinesand considering uncertainty about delays on arrival and about delays on departure.
- Uncertainty about delay on arrival *and* departure.
- M. Chaabouni (MIT, SM 1/99): Ground-holding times under "double-uncertainty".
- Implications for TFM operations and for CDM.

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Implications of CDM

- CDM may eventually have a profound impact on every aspect of ATM operat'ns
- In view of continuing tight terminal area constraints, CDM will be essential for attaining objectives and benefits of FF
- "Better strategic co-ordination based on shared information will provide more tactical freedom"
- Essential not to disregard need for basic research in this innovative environment