



A Trajectory Orientation Approach to En Route Strategic Planning

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Micro Analysis & Design



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Overview



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- Introduction
- Today's sector-oriented operations
- Trajectory Orientation
- Operational concept assessment
- The Upstream R-side/D-side Team operational concept
- Future Work



Introduction



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- Decision support tool (DST) technology has changed the way controllers do their jobs in the US National Airspace System (NAS)
 - URET used at ZID & ZME for conflict detection/trial planning
 - CTAS used at ZFW for metering
- NASA Ames Research Center began investigating potential changes to en route controller roles & responsibilities
 - 1984 early exploration
 - 1988 genesis of En route Descent Advisor (EDA) DST
 - 1991 air-ground integration (trajectory negotiation)
 - 1997 initiated operational assessment activities to parallel refinement of EDA
 - » Goal is to address key human-centered automation issues early in the development process



Today's Sector-oriented Operations



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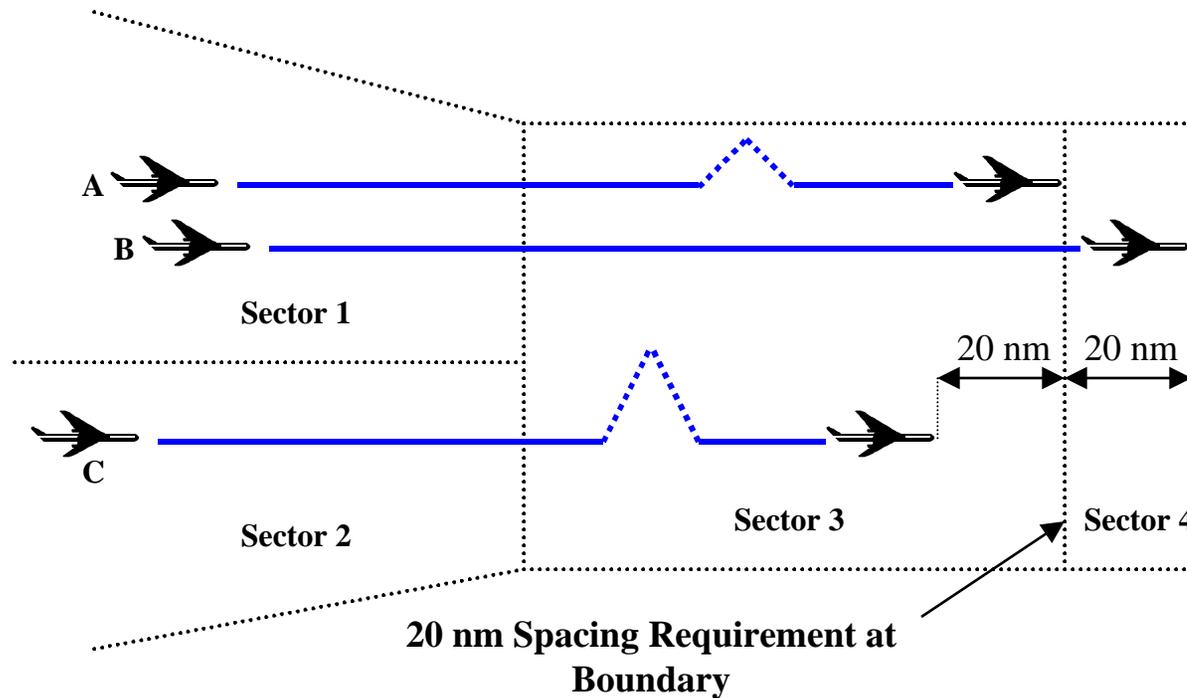
- Primary focus of en route controllers is on the planning and tactical separation of aircraft within their sector
 - Handoff procedure ensures that incoming flights are at least tactically separated
 - Delay maneuvers to meet MIT spacing or metering constraints are tactical and gross in nature
 - » To absorb large delays requires repeated vectoring
 - » Receiving controller has little visibility over the conformance of incoming flights to flow-rate constraints
 - The sector closest to flow-restricted airspace is usually the sector that is impacted the most
- Just enough cooperation to permit a handoff, but not enough to achieve an efficient flow of traffic



Today's Sector-oriented Operations



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Trajectory Orientation



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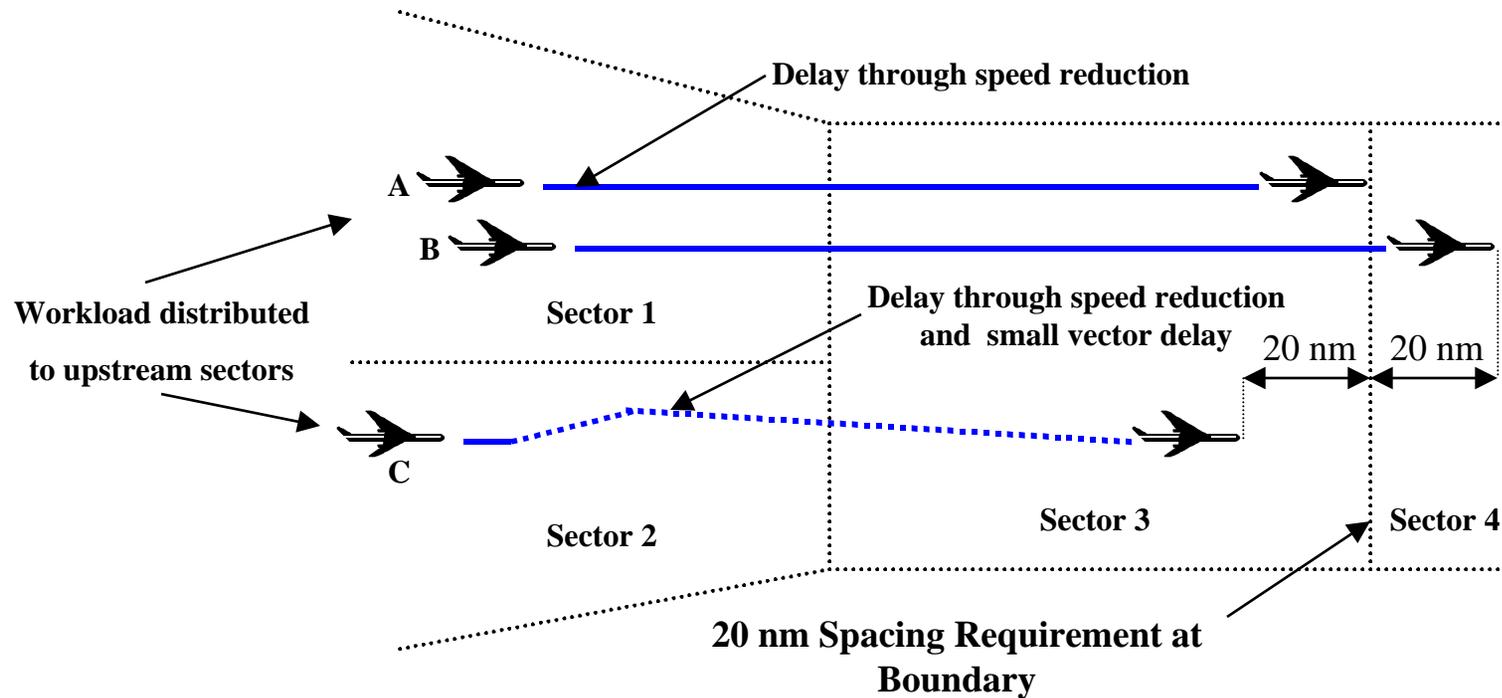
- An en route concept for inter-sector planning
 - Efficiently maintain separation and conform to flow-rate constraints
 - Clearances are issued in upstream sectors to resolve downstream problems
- Requirements
 - DST Capabilities
 - » Integrate flow-rate conformance and conflict resolution
 - » Accurate solutions/resolutions for 20 minute time horizon
 - New controller roles, responsibilities and procedures
- Not a new idea (AERA II and CTAS)
 - » Re-visit based on new research/technologies
 - » Characterize the operational concept



Trajectory Orientation



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Advantages of Trajectory Orientation



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- Distributes workload more evenly from downstream to upstream
- Reduces the need for tactical corrections
- Increase airspace capacity
 - Prevents inefficient spacing gaps or missed time slots
- Advanced Free Flight concepts (CE 6) become feasible options
- Longer time horizon increases utility of speed control
 - Fuel-efficient for the user
 - Clearances require less workload



Trajectory Orientation Operational Concept



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- If the predicted conflict/flow-rate conformance problem occurs in a sector downstream from the sector that currently “owns” the aircraft:
 - Which sector(s) should be alerted by the DST?
 - Which sector should be responsible for resolution?
 - Which controller position should resolve the conflict and/or issue the clearance?
 - » R-side, D-side, or a new position?
 - Which controller positions need the DST integrated into the DSR?



Trajectory Orientation Operational Concept Assessment



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- Goal: Evaluate set of operational concept configurations
- Assessment
 - Literature from AERA, URET, Eurocontrol PHARE and MSP
 - Controller interviews
 - » 6 controllers from Denver Center to refine approach
 - » 9 controllers/TM personnel from Cleveland Center
 - Busiest Center in USA
 - » Scenarios used to focus the interviews
 - Problem Type
 - Separation
 - Flow-rate conformance
 - Ownership



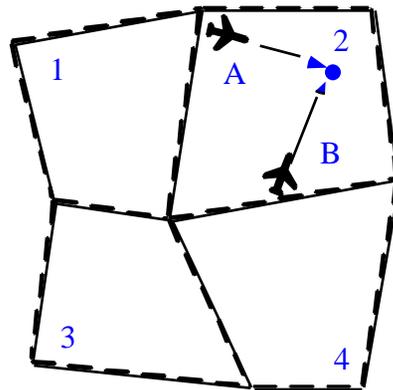
Problem Scenarios



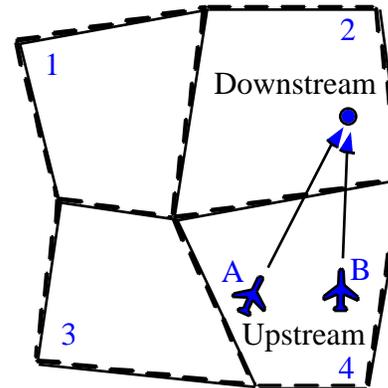
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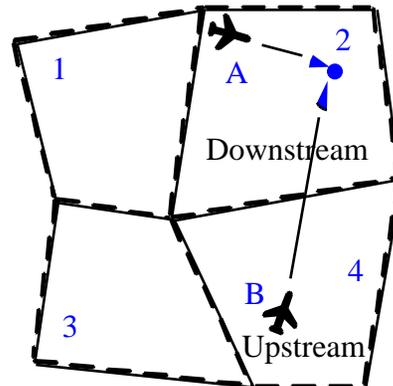
Case A
Intra-sector



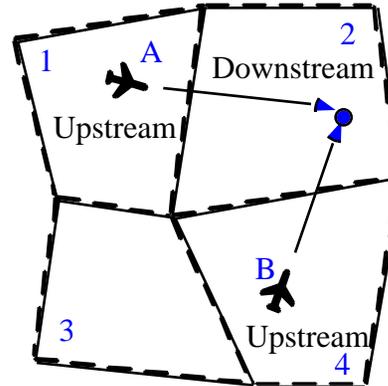
Case B
External



Case C
External Intruder

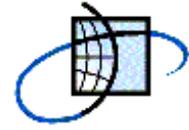


Case D
Inter-sector





Strategic Planning Issues in Today's Operations



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- Controllers are not responsible for resolving conflicts or meeting flow-rate constraints of other sectors.
- Strategic resolutions may
 - Be insufficient in resolving conflicts or meeting flow-rate constraints.
 - Interfere with an adjacent controller's plans.
 - Lead to conflicts with other aircraft because of inadequate situation awareness.
 - Have a lower priority compared to other controller tasks.
- Conflicts may resolve themselves because
 - They are actually false alarms.
 - Unpredictable events.
- Must account for simultaneous and conflicting actions by adjacent controllers.



Operational Concept Down Selection



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- 7 concepts were assessed
- Down-selected to 2 concepts
 - Upstream Team
 - » R-side and D-side perform strategic planning as a team
 - Sector that “owns” aircraft resolves downstream problems
 - Minimizes coordination with other sectors
 - Multi-sector planner
 - » New position that strategically plans flights for a group of sectors
 - Issues clearances via CPDLC
 - Autonomous, minimal coordination with sectors
- Upstream Team is first choice for more detailed research



Upstream Team Concept



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- Both R-side and D-side positions have access to DST displays
- R-side manages all tactical problems
- D-side maintains model of intent
- Advantages
 - Allows strategic planning during all traffic conditions
 - » including “rush” periods when needed most
 - Compared to MSP, clearances become effective immediately
- Disadvantages
 - Risk associated with evolving “upstream-based” procedures
 - » Most sectors must participate to realize net benefit



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Concluding Remarks

- What was achieved with this research?
 - Defined/refined the Trajectory Orientation concept
 - Chose a configuration to enable trajectory-oriented planning
- Future Work
 - Detailed roles, responsibilities, and procedures for Upstream Team
 - Validation of workload distribution
 - » Human performance modeling and fast time simulation
 - » Controller-in-the-loop experiments
 - How intent of controller and/or pilots is entered into the DST?
 - Collaboration
 - » FAA Technical Center Decision Support Automated Research
 - » CAASD via IAIP En Route Area Work Team
 - » Eurocontrol