Performance-Based Air Traffic Management

Evaluating Operational Acceptability

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Responding to the Challenges
Performance-based ATM Concept

- Responsibility for problem prediction moves from controller to automation
- Controllers resolve problems with automated resolution assistance
- Problems are predicted and resolved strategically
- Routine ATC tasks are automated
- Time-based metering used to manage traffic to constrained resources
- Airspace designed to optimize service and productivity improvements

- Automation assists with sequencing, merging, and spacing
- En route flow management directives smooth transition
- Organized, high-precision operations with deconflicted RNP/RNAV routes
- Aviation assists identification of route deviations and merging
- Additional routes available to increase flexibility, efficiency, and capacity
**Performance-based ATM Concept**

**Airspace Definitions**

**High-Performance Airspace**
- High-altitude cruise
- Area Navigation (RNAV) corridors into and out of some TRACONS
- Only for *aircraft with high-performance* navigation and communication capabilities
  - All RNAV capable
  - All have FMS integrated with data communications
  - Minimum Required Navigation Performance (RNP) requirement

**Mixed-Performance Airspace**
- Mid-altitude cruise
- Transitioning aircraft
- For *aircraft with a mix* of navigation and performance capabilities; some without data communications
  - All RNAV capable
  - Many have FMS integrated with data communications
  - No RNP requirement (but many capable)

**Traditional Airspace**
- Low-altitude cruise
- Airspace designated for operations that remain similar to operations in today’s NAS
- Most VFR operations

*Arrivals and departures with high high-performance navigation and communication capabilities*

*TRACON Airspace*
- For example, Potomac
- Primary/satellite airport RNAV/RNP procedures for arrivals, departures, and transition flights
  - All RNAV capable

*Small airport arrivals and departures*

*Primary/satellite airport arrivals & departures*
En Route Operations
Changes in the Controller’s Job

Performance-based ATM

- Integrated situation display
- Action List manages and resolution of problems
- Routine ATC tasks are automated
- Automation assists with TFM initiatives and pilot requests
- Voice communication
- Data communication
En Route Concept Validation
Human-in-the-Loop Experiments

- Twelve Front Line Managers from around the country
- Compared current operations (baseline) with concept of operations for Performance-based ATM
  - Increased traffic by 30%
  - Route and altitude constraints preserved
- Simulations with selected sectors in Indianapolis and Washington ARTCCs with 2015 traffic levels
  - Sector 75 – proximity and transitioning complexity
  - Sector 72 – departure transitioning from New York and Washington airports
En Route Experiment Results
Controller Workload

Indianapolis Sector 75
Baseline Operations vs. P-ATM Operations

Minutes into Simulation

Aircraft Count

Workload Rating

P-ATM Aircraft Count
Baseline Aircraft Count
P-ATM Workload
Baseline Workload
En Route Experiment Results
Controller Workload (concluded)

P-ATM Operations with Expanded Volume

Aircraft Count

Workload Rating

Minutes into Simulation
Terminal Concept Validation
Human-in-the-Loop Experiments

- Compared Baseline (conventional) operations with Performance-based ATM operations using current position and combined position scenarios
  - Maximum airport capacity rates used
  - Traffic levels remained constant
- Full and individual capabilities evaluated
  - RNAV/RNP procedures
  - Data communications
  - Ground-based automation tools
Terminal Operations
Changes in the Controller’s Job

Performance-based ATM

Pre-planned RNAV/RNP Routes with procedural separation, altitude and speed clearing,

Improved Traffic Mgmt and automation support
- Merging and sequencing

Data Communications for handoffs, as available

Manual support for Route Conformance and conflicts

Automation/Data Comm to Minimize Routine Tasks
Terminal Concept Validation
Human-in-the-Loop Experiments

- Examined Atlanta TRACON operations with Atlanta Supervisors
- Compared current operations with concept of operations for P-ATM
- Evaluated whether one controller could work both the feeder and final airspace
- Simulations at maximum airport capacity
Terminal Experiment Results
Controller Workload

Large TRACON Operating Environment (A80)
Feeder-Final Position Combination

- Reduction of controller-pilot communications and time on frequency between Baseline and P-ATM conditions
  - 79% reduction in the amount of communications
- Scenario with scripted exception events (e.g., route deviations) included
  - Resulted in slight increase of workload
  - Overall workload results still better than conventional operations (Baseline Uncombined)
  - 61% reduction in the amount of communications between Baseline Combined and P-ATM with Upset Events
Terminal Experiment Results
Controller Workload

- P-ATM condition evaluated did not include data communications
- Reduction of controller-pilot communications and time on frequency between Baseline Combined and P-ATM conditions
  - 28% reduction of communications
- Scenario with scripted exception events (e.g., route deviations and missed approaches) included
  - Resulted in higher workload but was not considered overload

Large Complex TRACON Operating Environment (I90)
Feeder Position Combination

![Graph showing workload ratings over time for different conditions.](image-url)
Performance-based ATM Concept
Next Steps in Evaluating the Concept

• Lower Level TRACON Evaluation results being analyzed
  – West Palm Beach
• Evaluations July 16 – August 2, 2007 with En Route Front Line Managers
  – Levels of Data Comm. Equipage
  – Severe Weather
  – Exceptions and Failures
• Extending Functionality in FY08
  – Integrated Time-Based Flow Management
  – Automated Terminal Route Integrity Monitor
  – Terminal automation for route integrity monitoring and data communication