Using Simulation in NextGen Benefits Quantification

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Simulation Model Spectrum

Analytical models (e.g. Excel based)

Queuing/network models

Superfast-time simulation models
  Medium-to-high detail
  Entire NAS

High-fidelity fast-time simulation models
  Airport surface / TRACON
  Group of sectors to Center

Real-time Human-in-the Loop simulators

DART
“Weather-aware”
“NextGen-aware”
Highly detailed
Day-in-the NAS in 2 min
NAS, 07/08/11, 00Z, 3,800 flights in the air

DART:
Weather-Aware, Runway-to Runway, Superfast-Time
NAS/ATM Simulation Model
Examples of DART Supported NextGen Benefit Analysis Studies

- NextGen technology elements
  - DataComm, ELVO, NVS, RNP-E
  - Technology Portfolios
  - Equipage and traffic growth scenarios, e.g. through 2030

- NextGen weather products and tools
  - CSS-WX, NWP

- New procedures (Wx related), technology driven benefits
  - CATMT, EDR

- New procedures, safety concerns – dis-benefits
  - CRO, Winter weather
A sample DART NextGen portfolio-of-technologies study output (including DataComm). This batch required 16,000 simulations, each representing a full day in the US NAS with 40-60,000 flights, weather, forecasts, and NextGen technology effects simulation, and took 5 days to complete.
Improved Convective Forecast Accuracy – Benefit Analysis Using DART

- A range of forecast product features evaluated in DART using an entire convective season (instead of a handful of weather situations)
- Simulated operational benefits (reduced excess operating costs) of:
  - Improved forecast accuracy (from ‘current’ to ‘more accurate’ to ‘perfect’)
  - Use of convective echo tops forecast information
  - Operational impact of using finer weather grid resolution
  - More effective use of TMIs, more streamlined reroutes
CoSPA with Echo Tops, 3D View

Wx at FL400 shown
Flight N255QS
crusing alt = FL430
Back-up Slides
DART for Assessing “Value” of Alternative ATM Strategies/Decisions *(Realized or Needed)*

An Example

**Optimized solution:** Airway J29 open to relieve traffic on VUZ playbook reroute; reduced MIT, less delay

**Non-optimal solution:** VUZ playbook reroute traffic uses standard route; J29 closed; heavier MIT, longer delays

Only the traffic using select NAS Playbook reroutes is shown; Color-coding by delay: 0-15, 15-20, 30-60, 60-120, >120 min arrival delay
Validation Using a Multi-Day Period

NAS metrics obtained from DART over a multi-day period (e.g. an entire convective season) are compared with historical data from FAA statistics.

ZDC distribution of flight altitudes

NAS arrival delays – daily totals

Delays - DART Simulation (Actual Traffic Demand) w. LAMP En-route Rechecks vs. ASQP Arrival Delay

Distribution of Flight Altitudes in Sector 9: TFMS v. DART

Distribution of Flight Altitudes in Sector 35: TFMS v. DART

Distribution of Flight Altitudes in Sector 39: TFMS v. DART

Distribution of Flight Altitudes in Sector 54: TFMS v. DART
Validation Using a Multi-Day Period

Normalized RMSE is a measure of DART-vs-ASQP variance error over the entire convective season.

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NAS cancellations – daily totals

Cancellations - DART Simulation (Actual Traffic Demand) w. LAMP En-route Rechecks vs. ASQP - ASPM77 Airports - Summer 2011
Selected DART Output Metrics

- Delays/Cancellations/Diversions/Reroutes Statistics
  - Delays by type (ground, airborne, holding), cause (e.g. airport capacity, runway, en-route weather, GDPs, AFPs, etc.), and stage (departure, en-route, approach)
  - Scope: by individual air carrier, by airport, and the NAS summary for the day
  - Excess operating costs can be computed from these outputs
- Hourly movements and delays for major airports
- Traffic demand, directional capacity and occupancy for all Sectors/Centers
  - Original demand, demand adjusted by DART, capacity degradation due to diagnostic and forecast weather, maximum and average occupancy every 15 min
- “Denied sector entry requests” as a measure of airspace availability
- Sector events
  - Entry/exit, altitude changes, vectoring, airway transitions, potential conflicts, etc.
- Airway weather impact statistics
- Individual flight statistics (Dep/Arr times, route length, delays, Wx impact)
- Flight plans and 1-min trajectories exported in flat-file TFMS/ASDI format
- WITI metrics (en-route, TRACON, terminal, Centers, Flows)