



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

DART

“Weather-aware”

“NextGen-aware”

Highly detailed

Day-in-the NAS in 2 min

High-fidelity fast-time simulation models

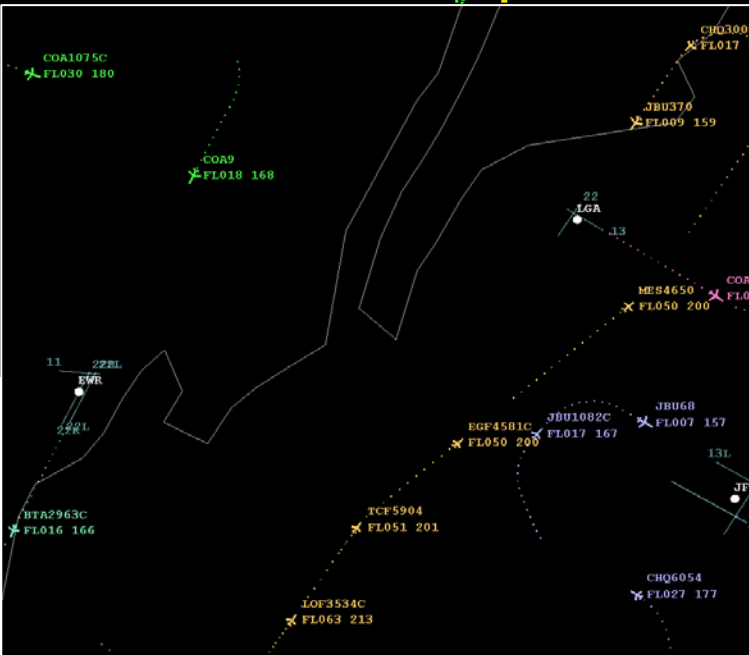
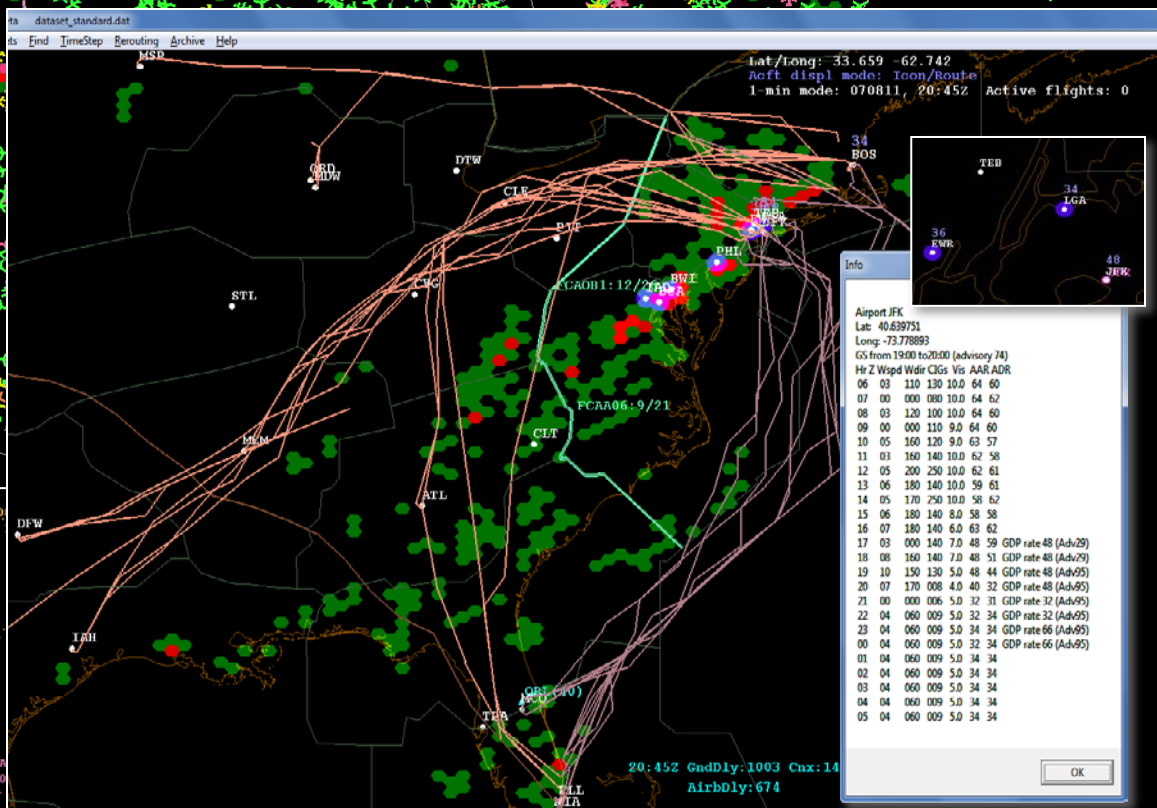
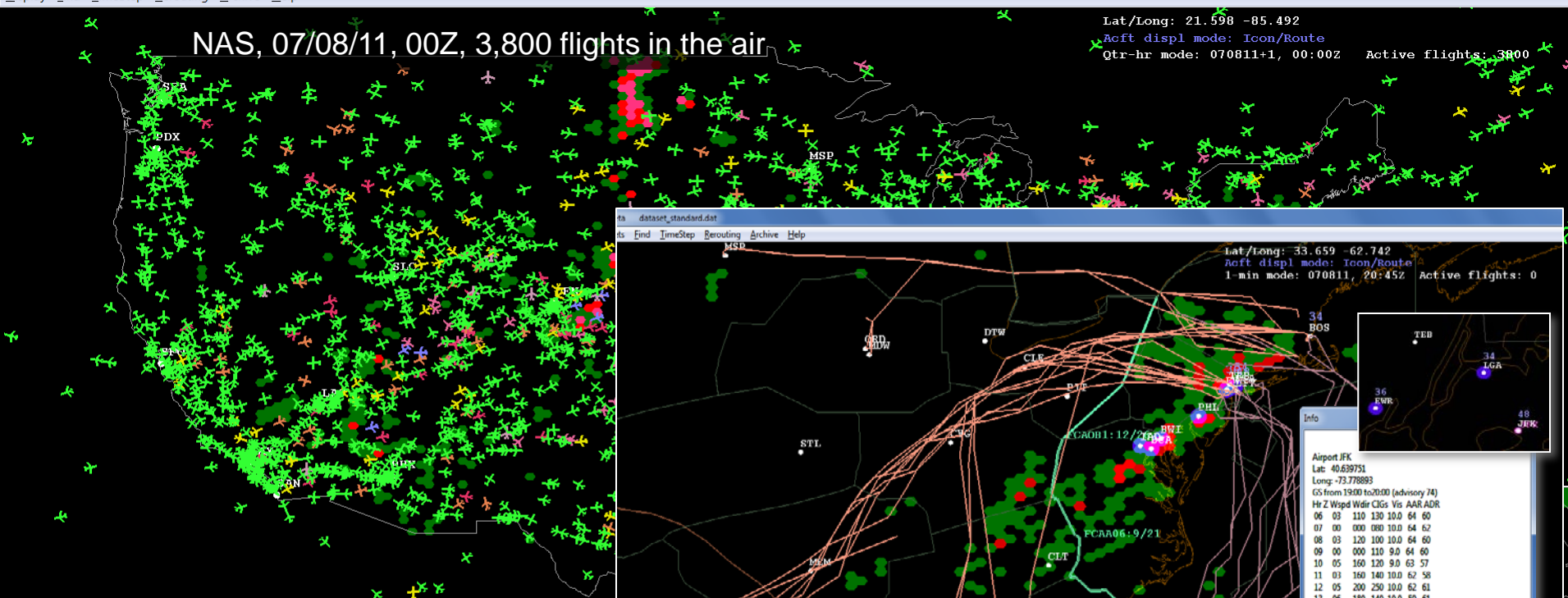
Airport surface / TRACON

Group of sectors to Center

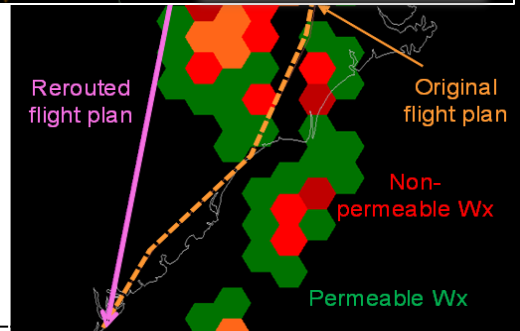
Real-time Human-in-the Loop simulators

NAS, 07/08/11, 00Z, 3,800 flights in the air

Lat/Long: 21.598 -85.492
Acft displ mode: Icon/Route
Qtr-hr mode: 070811+1, 00:00Z Active flights: 3800



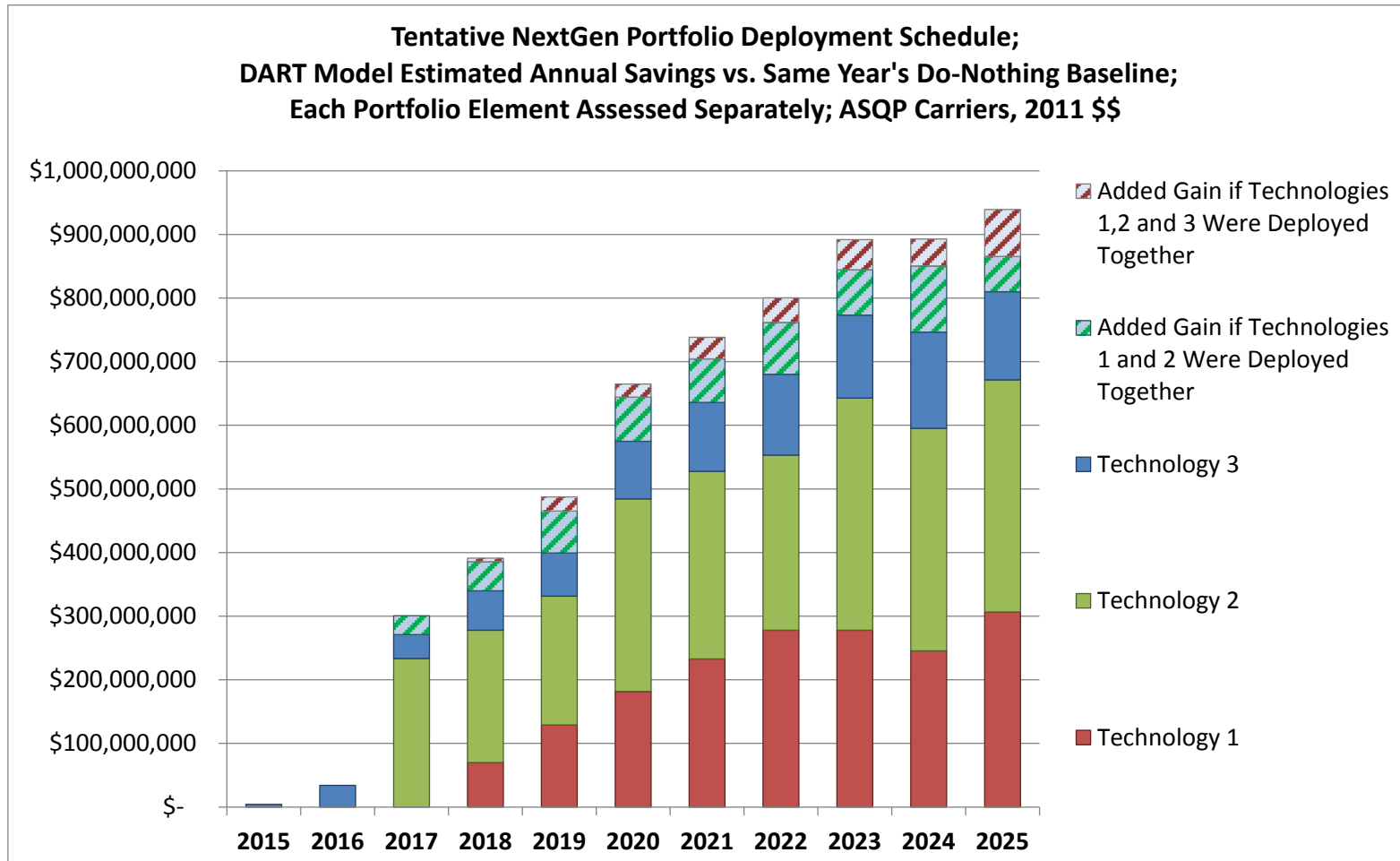
DART:
Weather-Aware,
Runway-to Runway,
Superfast-Time
NAS/ATM Simulation
Model



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

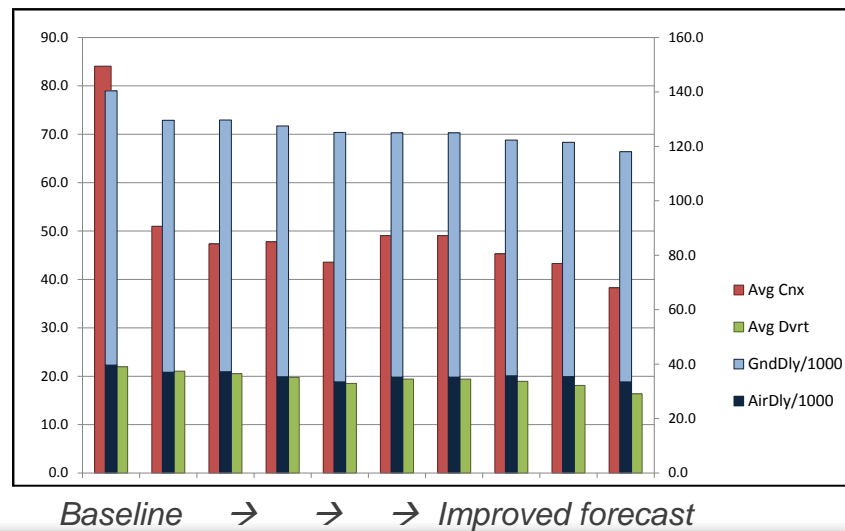
DART Next-Generation ATM Study Example



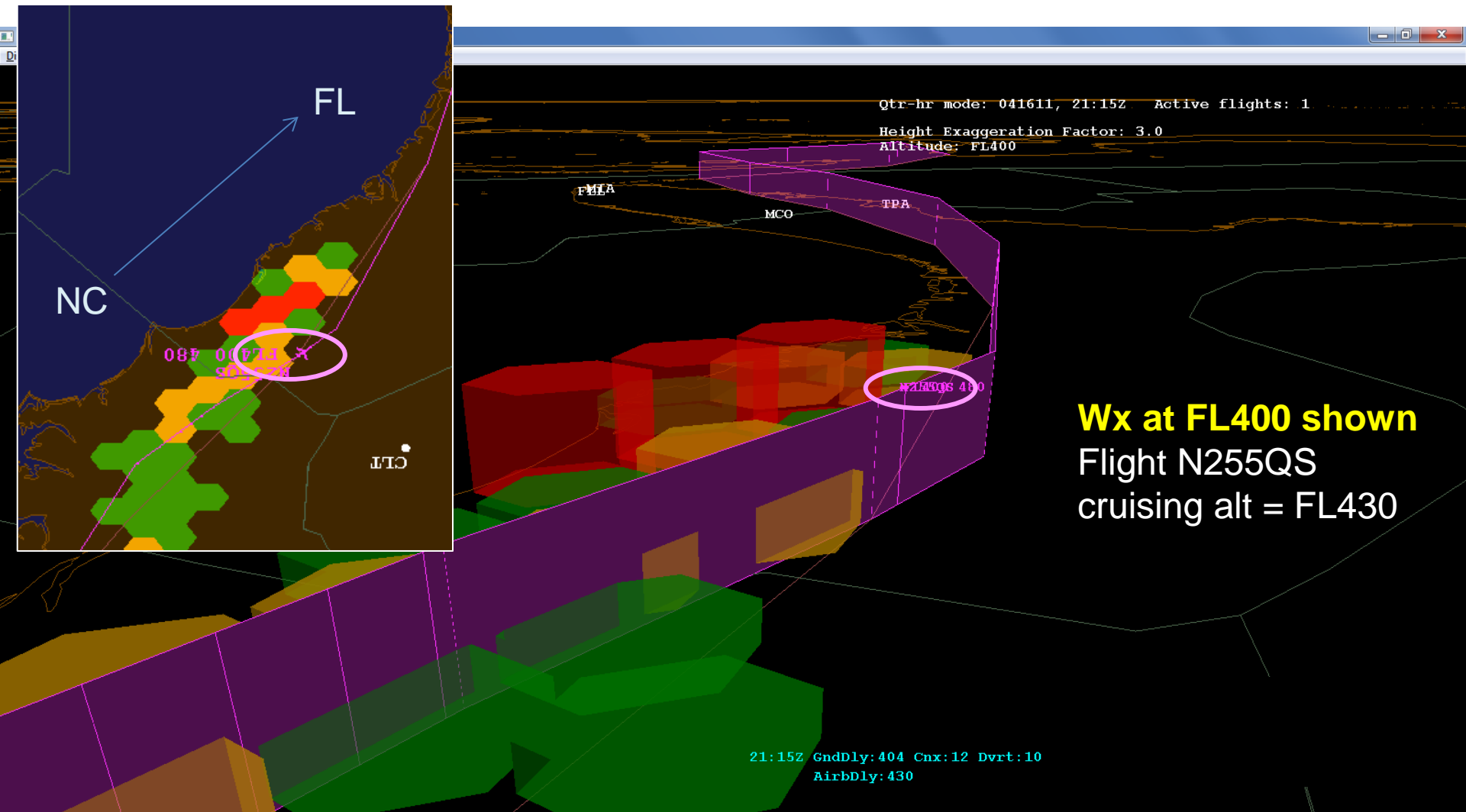
A sample DART NextGen portfolio-of-technologies study output (including DataComm). This batch required 16,000 simulations, each representing a full day in the US NAS with 40-60,000 flights, weather, forecasts, and NextGen technology effects simulation, and took 5 days to complete.

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 TMs, more streamlined reroutes



CoSPA with Echo Tops, 3D View

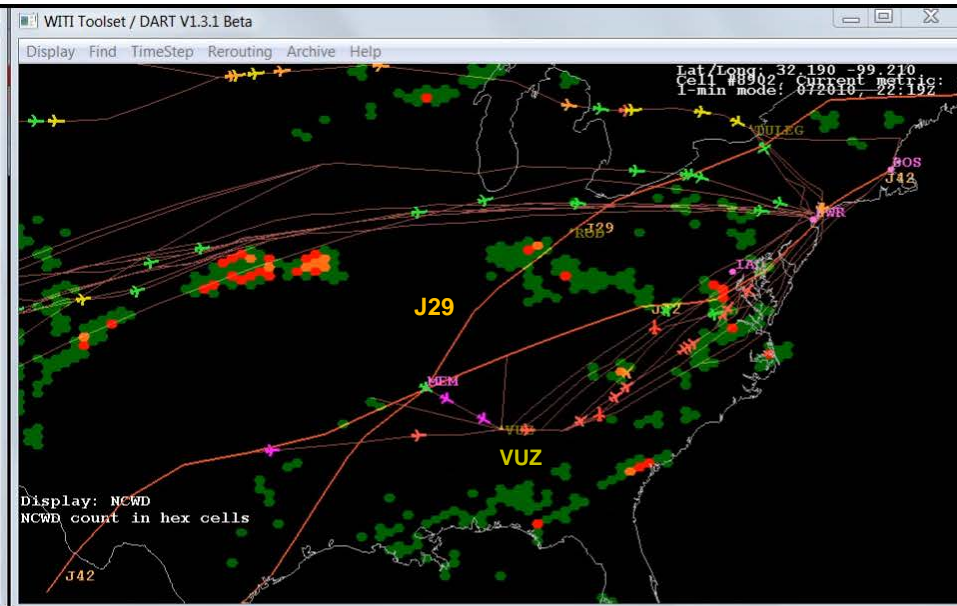
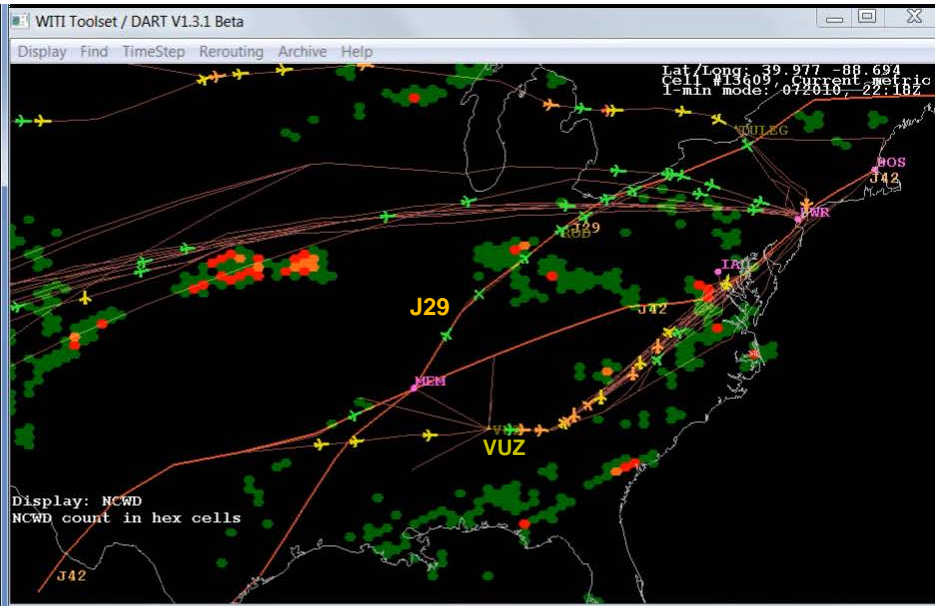


Back-up Slides



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

TOTAL On-the-ground (at gate) Delay Savings (hr)	Airborne Holding Delay Savings (hr)	Airborne Reroute Delay Savings (hr)	TOTAL Airborne Delay Savings (hr)	TOTAL Delay Savings (hr)	# Reduced Cancellations	# Reduced Diversions	Reduced #Flights Delayed >2 hours
153.9	-2.2	3.4	1.2	155.0	31	1	54



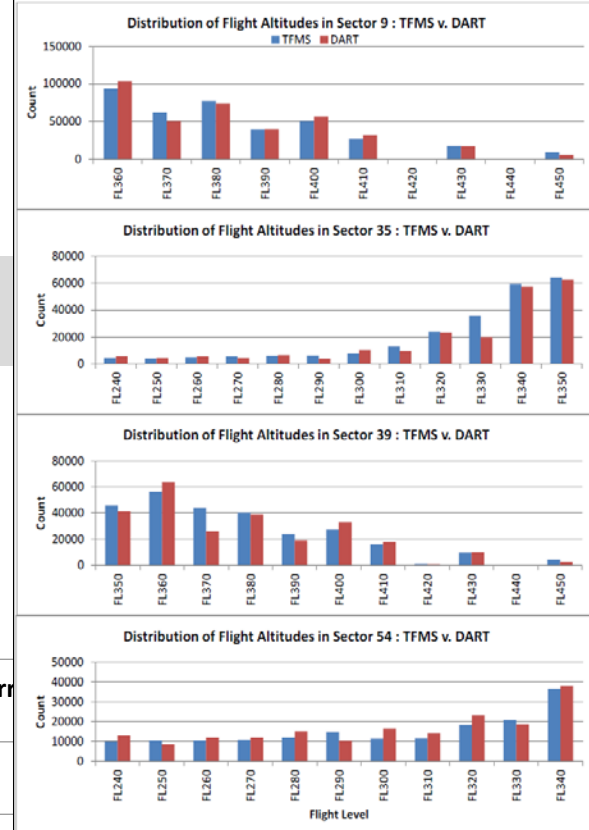
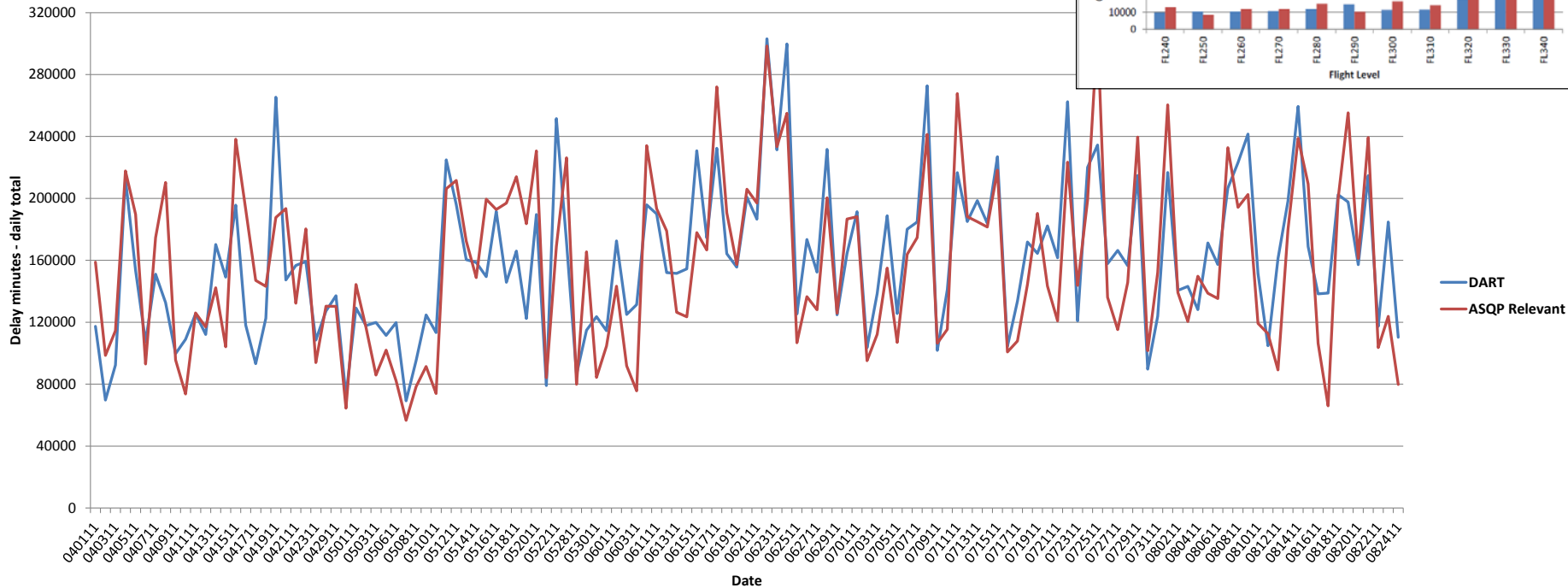
Validation Using a Multi-Day Period

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 Arr



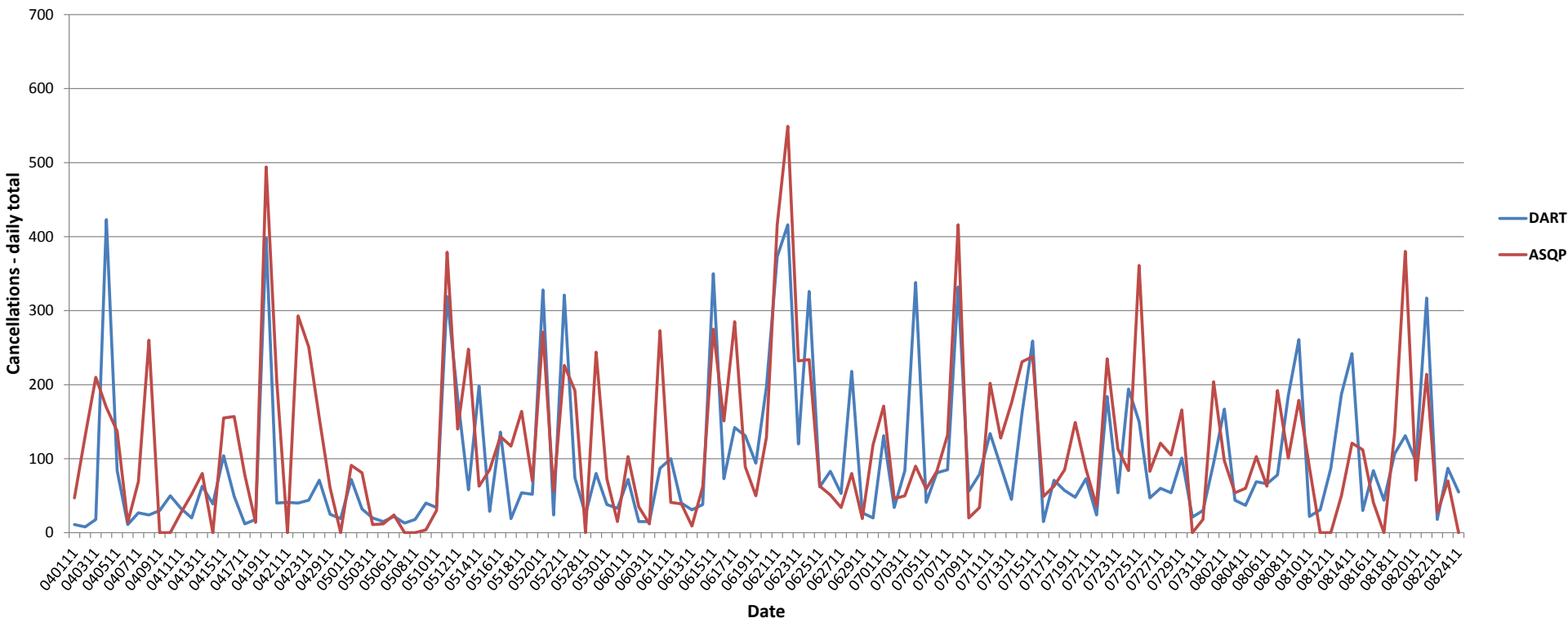
Validation Using a Multi-Day Period

<i>Normalized RMSE</i>		
<i>Arr Delay</i>	<i>Cnx</i>	<i>Diversions</i>
13%	16%	15%

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

NAS cancellations – daily

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)