Self-Assessment of Boeing/Metron 2020 Gate-to-Gate Concept

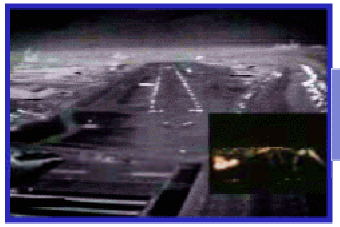
Al Sipe, Principle Investigator

February 10, 2004

Operational transformation

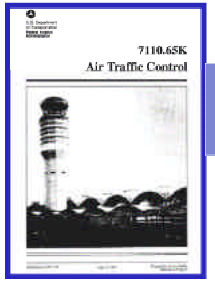
Air traffic controller → Air traffic manager

Present aircraft state → Future aircraft intent



Aircraft centric → System centric

Independent decision support tools → Integrated traffic management tools



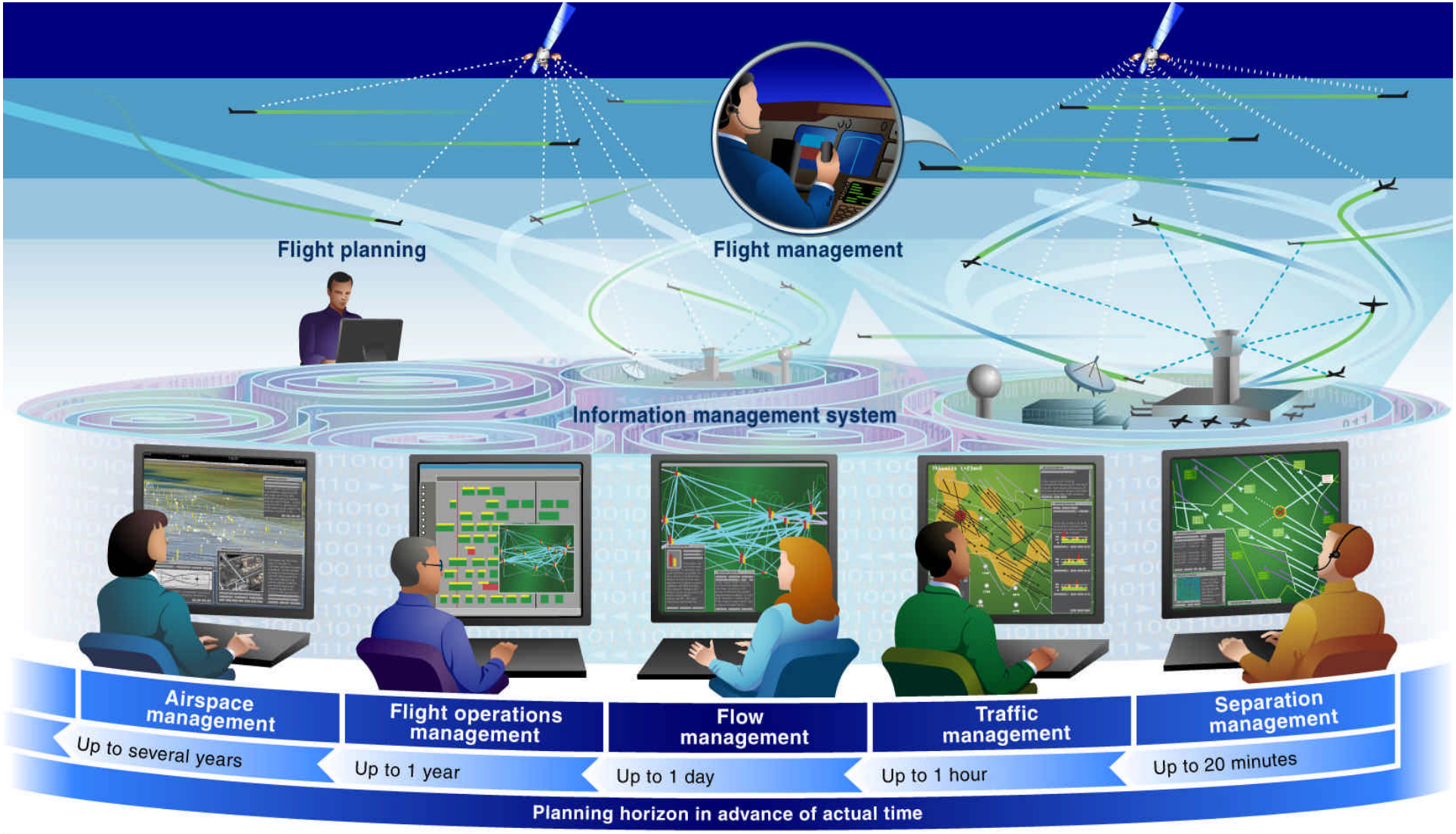
Radar-based operations → RTSP-based operations

Independent gauges → Integrated cockpit

Agenda

- OPERATIONAL CONCEPT CORE IDEAS
- CONCEPT ASSESSMENT METHODOLOGY AND MODELS
  - Metrics
- CONCEPT ELEMENTS OPERATIONS ASSESSMENT
- DELAY ASSESSMENT
  - Airport Capacity Assessment
  - Airspace Capacity Assessment
  - Concept Delay Assessment
- INVESTMENT ASSESSMENT
- RESULTS AND LESSONS LEARNED
- CONCEPT REFINEMENTS
- CHALLENGES AND PLANS

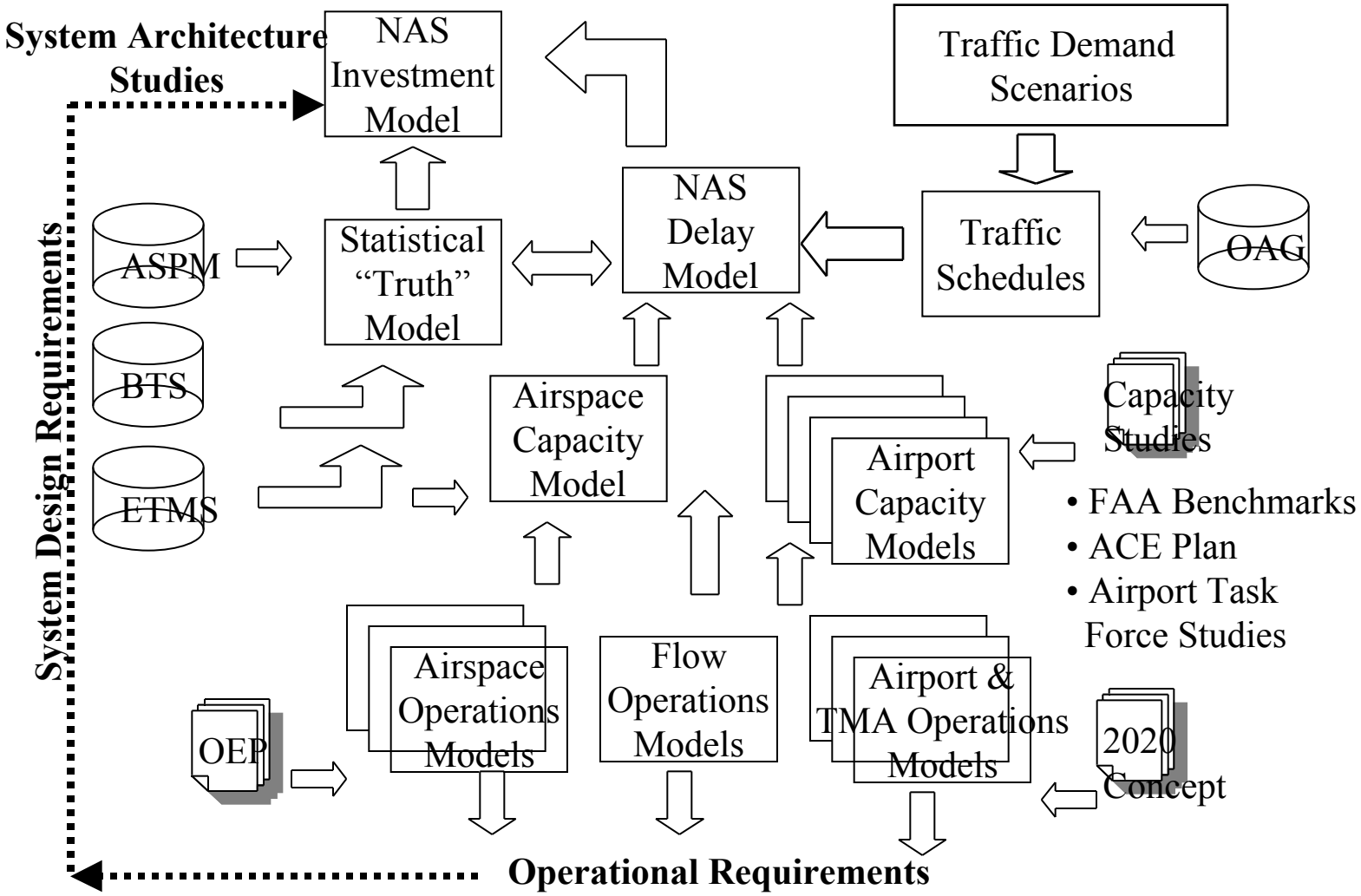
2020 operational concept



Summary of 2020 operational concept

- Integrated services
  - Airspace, Flow, Traffic, and Separation all working to the same objectives
  - Control coordinated by Time Horizon, No more uncoordinated control actions
  - Core services time horizons for prediction, detection, and control
  - Detection accuracy and criticality for air traffic services
  - Future projection of traffic/weather/resource picture based on flight paths
  - Shared future projection
  - Comprehensive, performance-based framework
  - Coordinated flight replanning
  - Traffic planning across domains
- RTSP based airspace control
  - Airspace rules are dynamic according to infrastructure, weather, and traffic constraints
  - Required Total System Performance (RTSP) based flight planning
- Precision Procedural Control
  - Trajectory-based flight planning
    - Aircraft flies the Filed Flight Path
    - Flight Paths are limited by TERPS, SUAs, etc.
  - Enriched flight planning, objectives as well as path
  - Dynamic flight plan updating

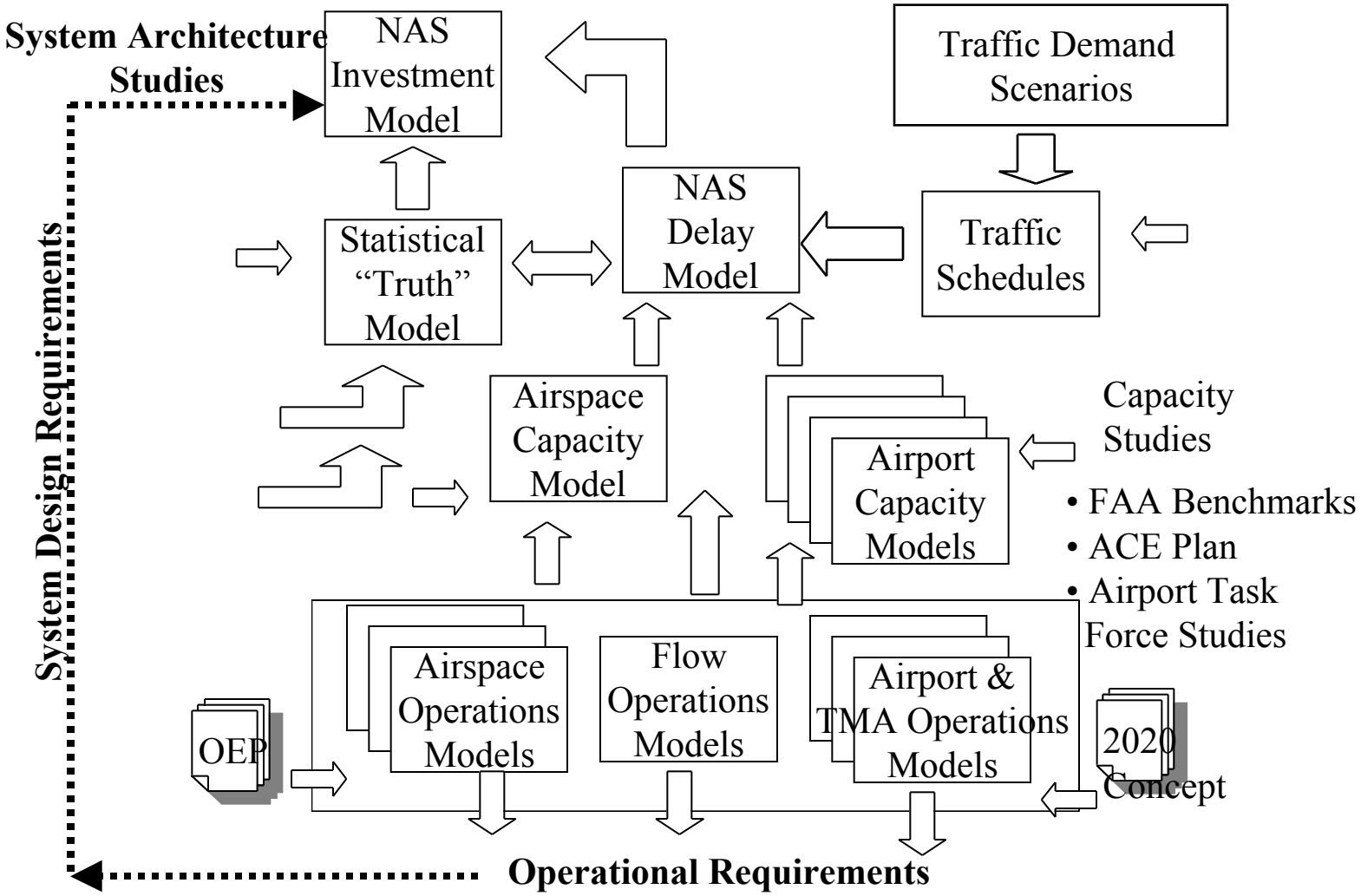
Concept assessment methodology and models



Operational Metrics for Phase 2

Level 1	Opportunity cost **(Billions of dollars per year saved relative to maintaining 2000 baseline)**
Level 2	NAS Capacity **(# of operations per year at base level of delay)**
Level 3	Airport Capacity **(AAR and ADR)** Airspace Capacity **(MAP values)**
Level 4	ROT **(seconds, mean and std dev)** **... ... ...**
Level 5	TD Dispersion **(feet @2σ, feet @4σ)** Braking **(feet/sec/sec)** Approach gate spacing **(seconds @1s)** Rollout **(seconds, @1σ)**

Concept elements operations assessment

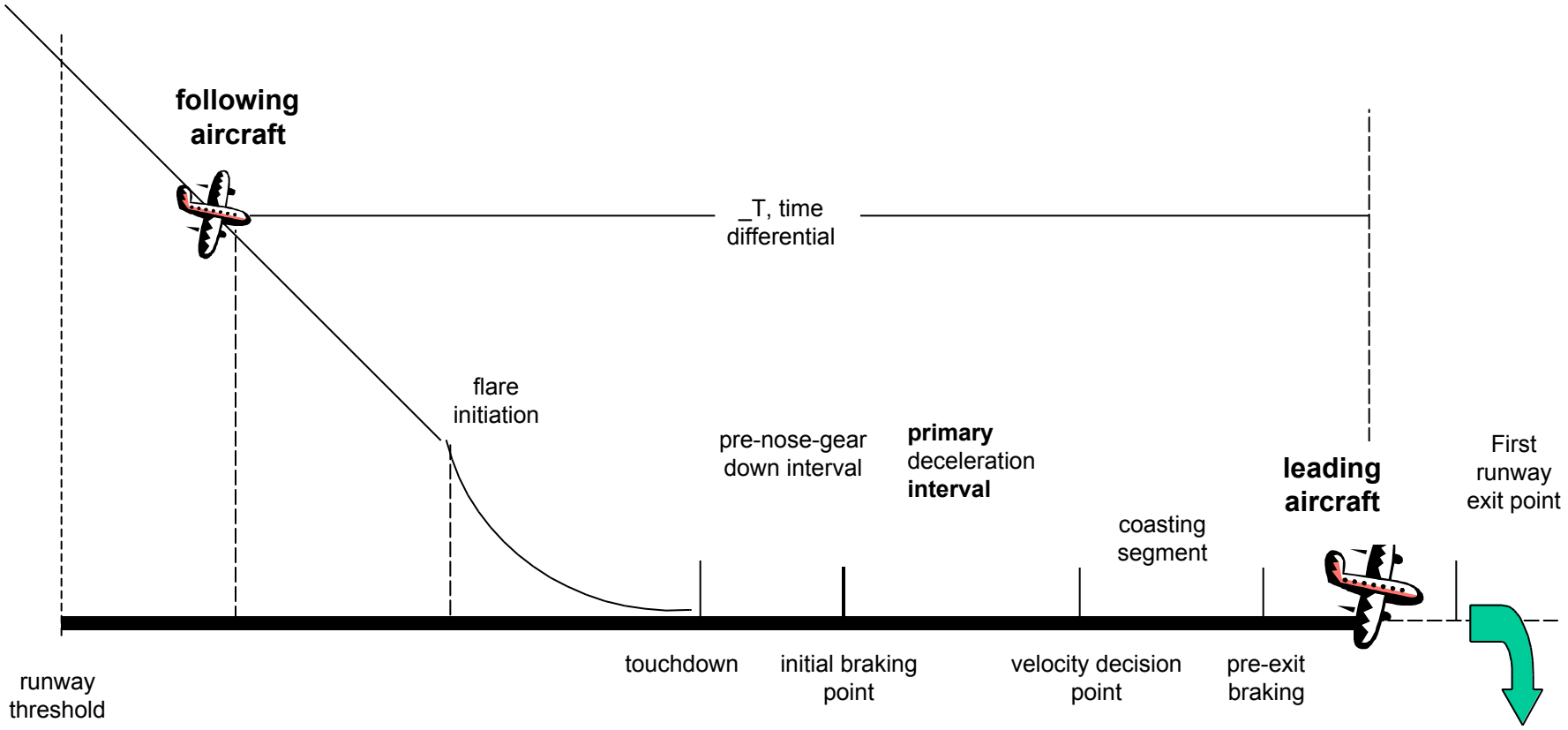


Concept elements operations assessment

- Runway Management
- Closely Spaced Parallel Runway Operations
- Advanced Flow Management
- Sector Productivity
- Enhanced Surface Management
- Extended TMA Routing, Sequencing and Assignment
- IMC and MVMC Final Approach Spacing

Runway Separation Management (VMC)

Basic Sequence of Events

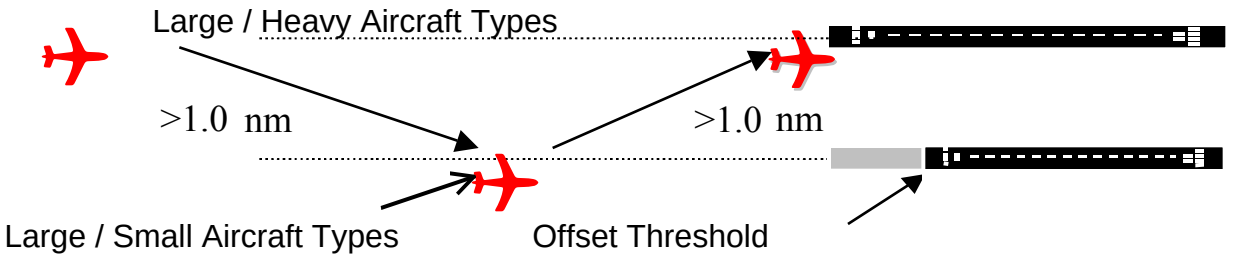


Closely Spaced Parallel Runway Operations to 1,200 ft (IMC and MVMC)

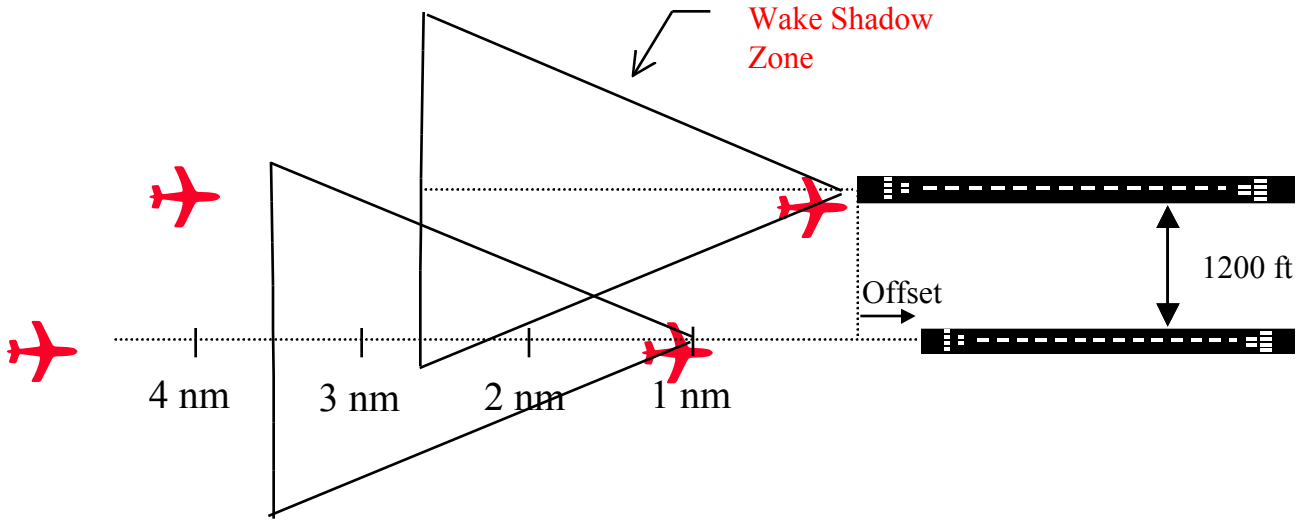
Staggered Dependent Approaches Concept with Offset Threshold

IFR Dependent Approaches:

1,200 ft < **Rwy** Sep < 2,500 ft



Paired Approaches with Staggered Glideslopes Concept

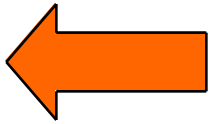


Initial Operational Performance Analysis for Runway Management

Concept Core Ideas

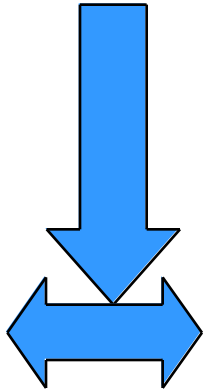
- Traffic Planning across Domains
- Trajectory Based Planning
- Precision Procedural Control

Runway Operational Analysis Process



Domain Constraints

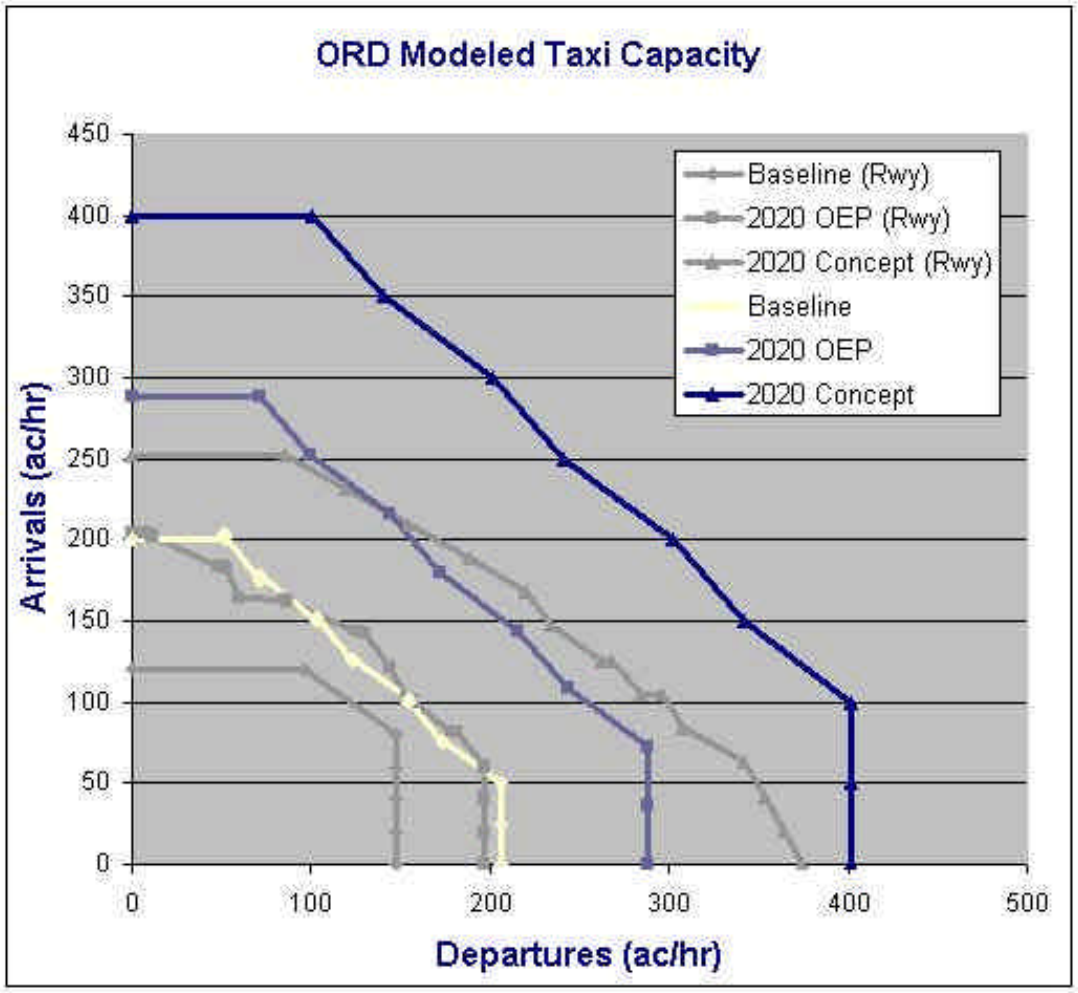
- ROT
- Wake Vortex
- Radar Rules
- Noise & Emissions



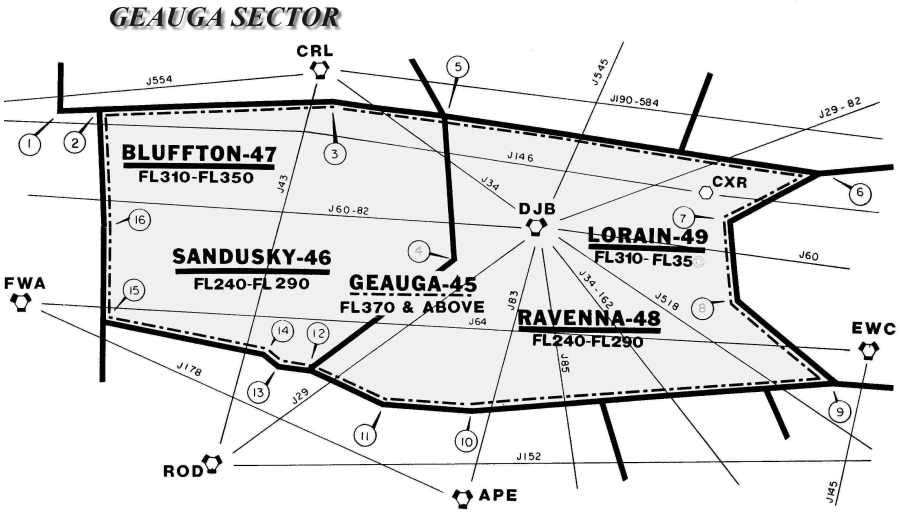
Operational Requirements

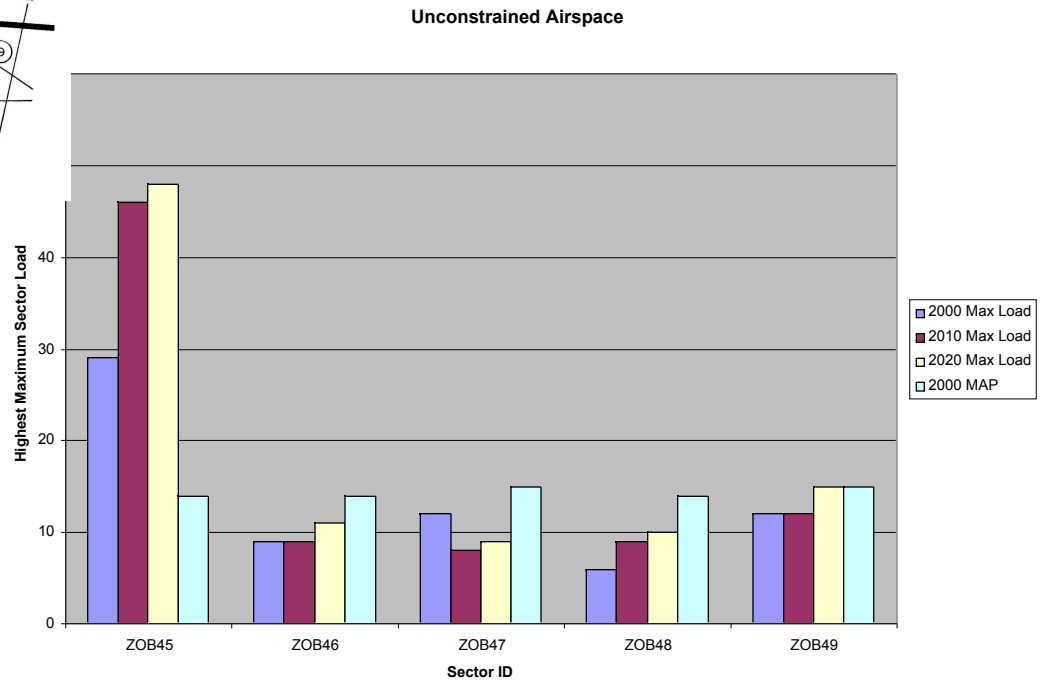
System Requirements

Enhanced Surface Management

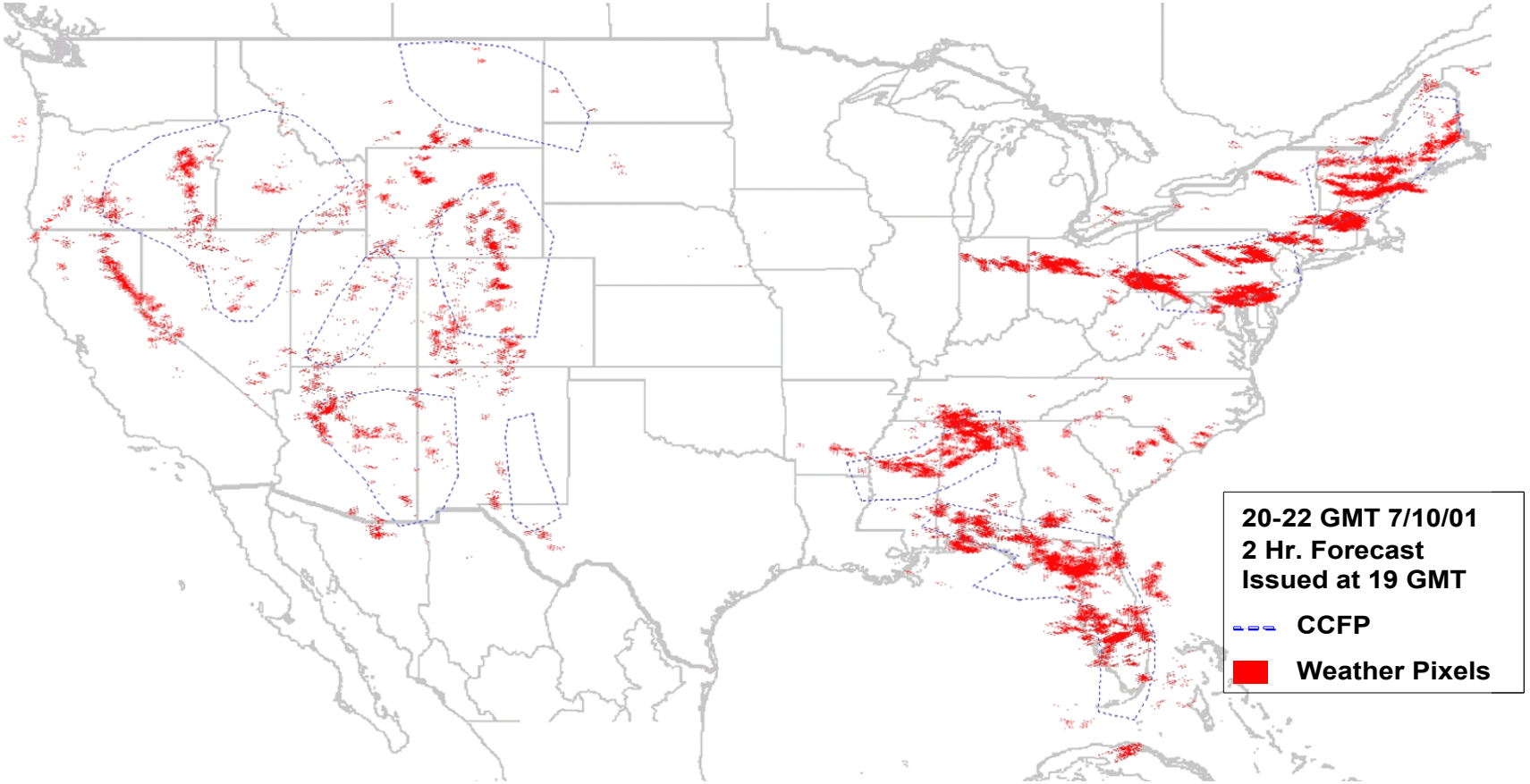


Sector Productivity

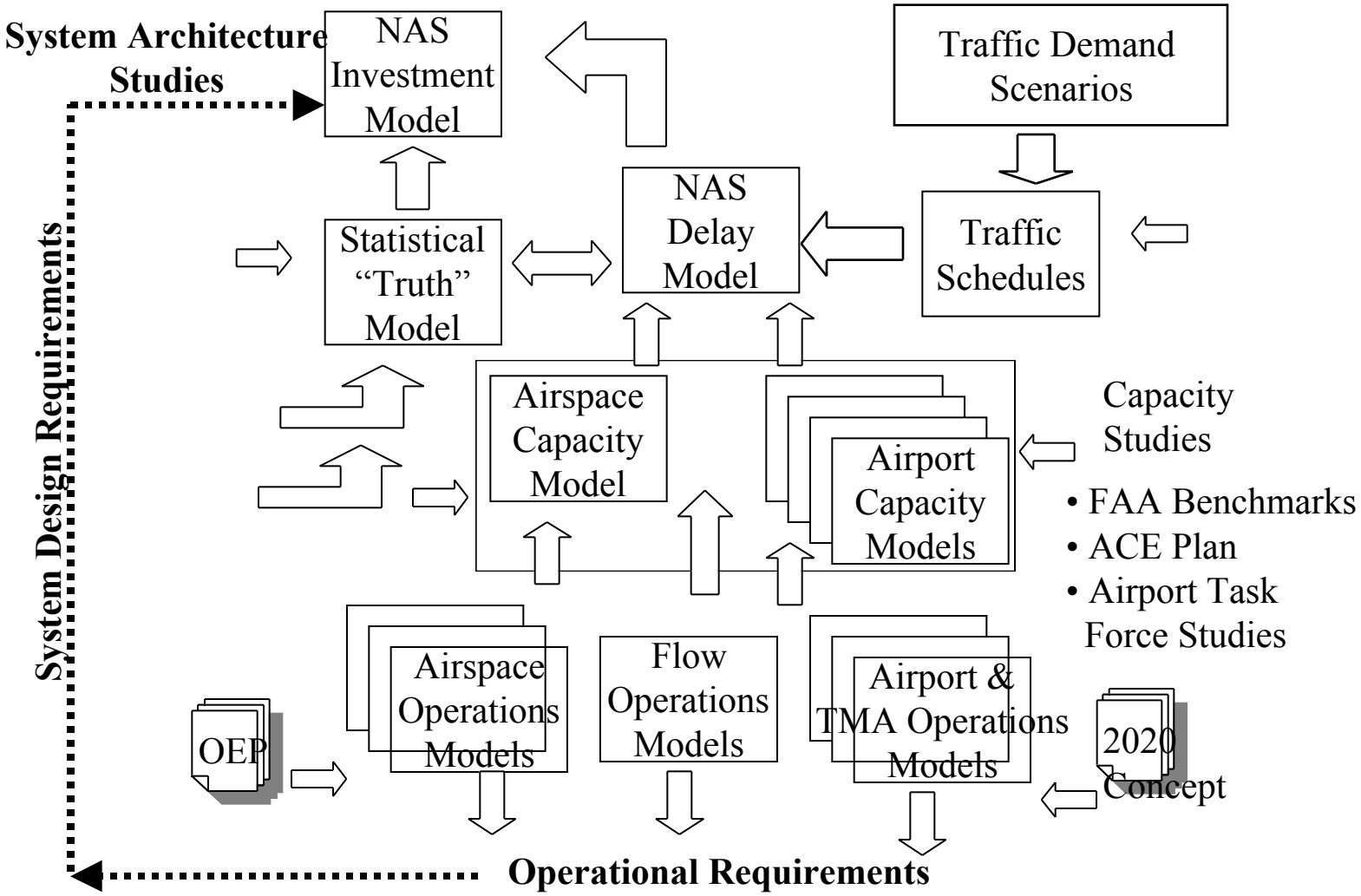




Flow Management Operational Assessment



NB: Weather pixels are from NOAA/Forecast System Laboratory's CC FP Real-Time Verification System's.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Traffic Demand Scenarios
NAS Delay Model
Statistical "Truth" Model
Traffic Schedules
Airspace Capacity Model
Airport Capacity Models
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• FAA Benchmarks
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• Airport Task Force Studies
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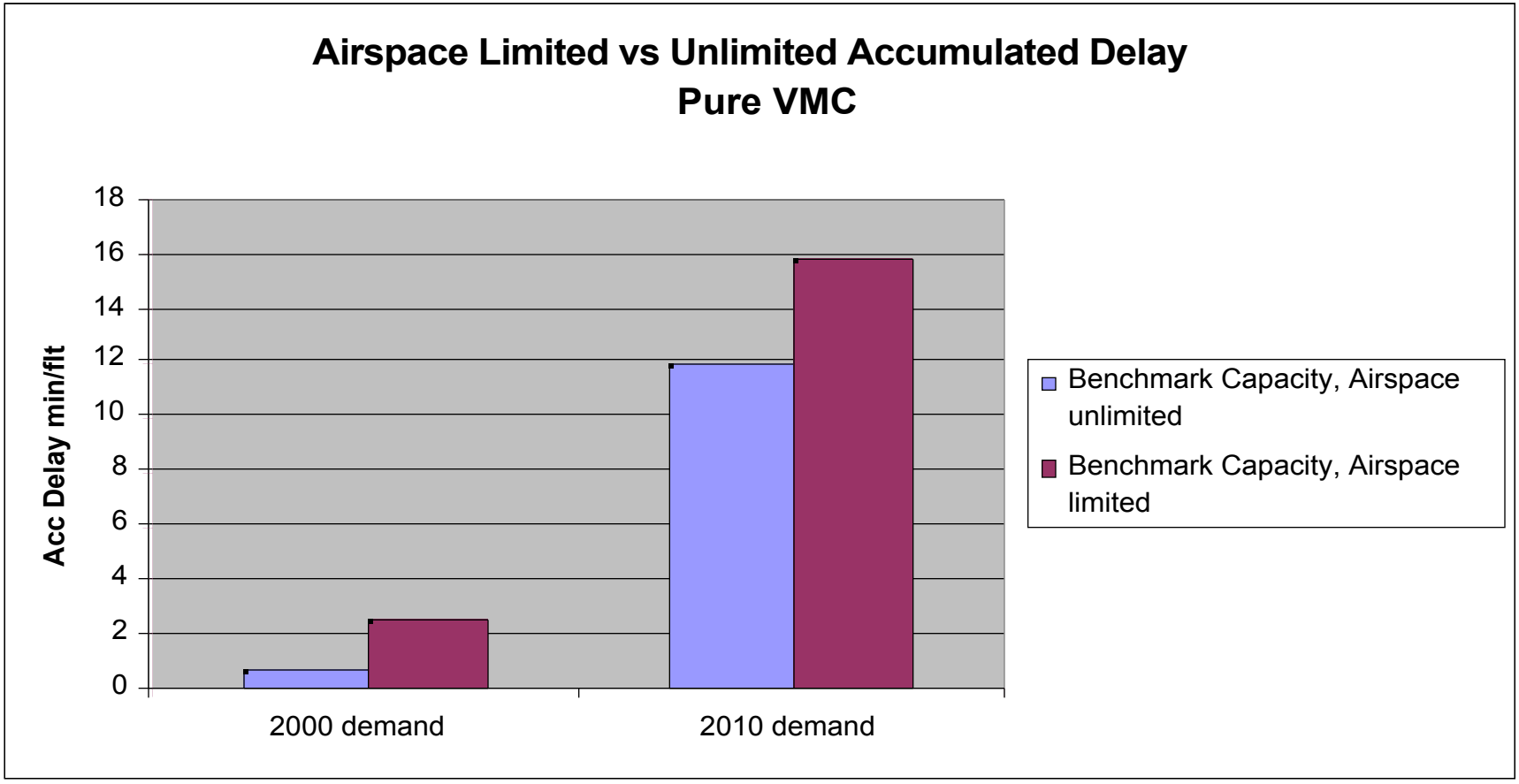
Flow Operations Models
Airport & TMA Operations Models
OEP
2020 Concept
System Design Requirements
Operational Requirements

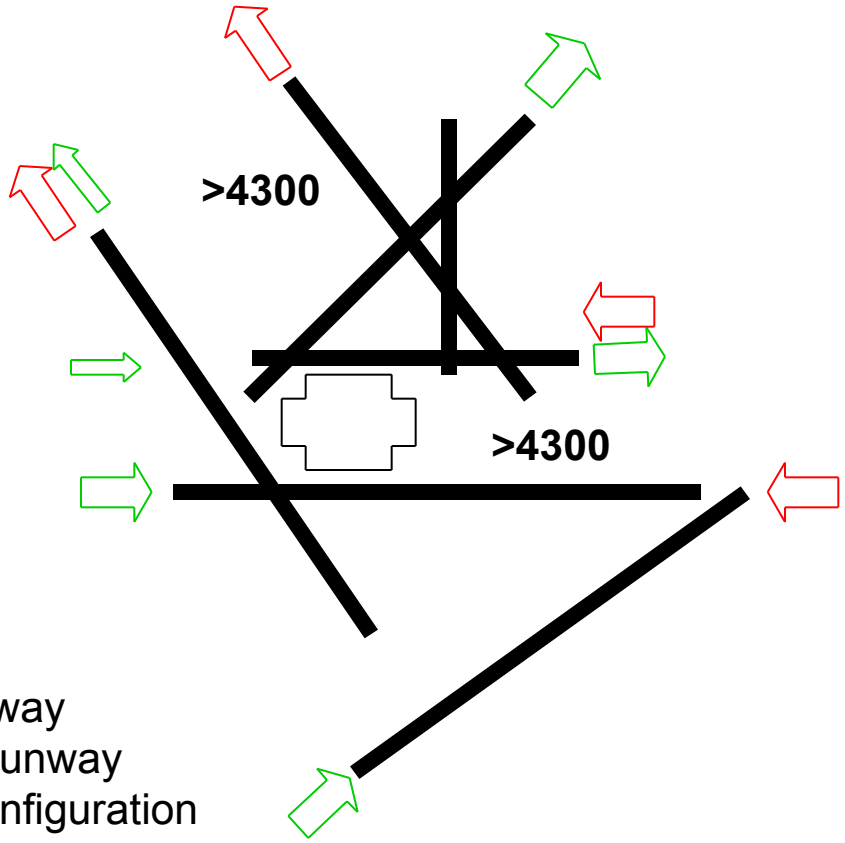
Airspace Capacity Assessment



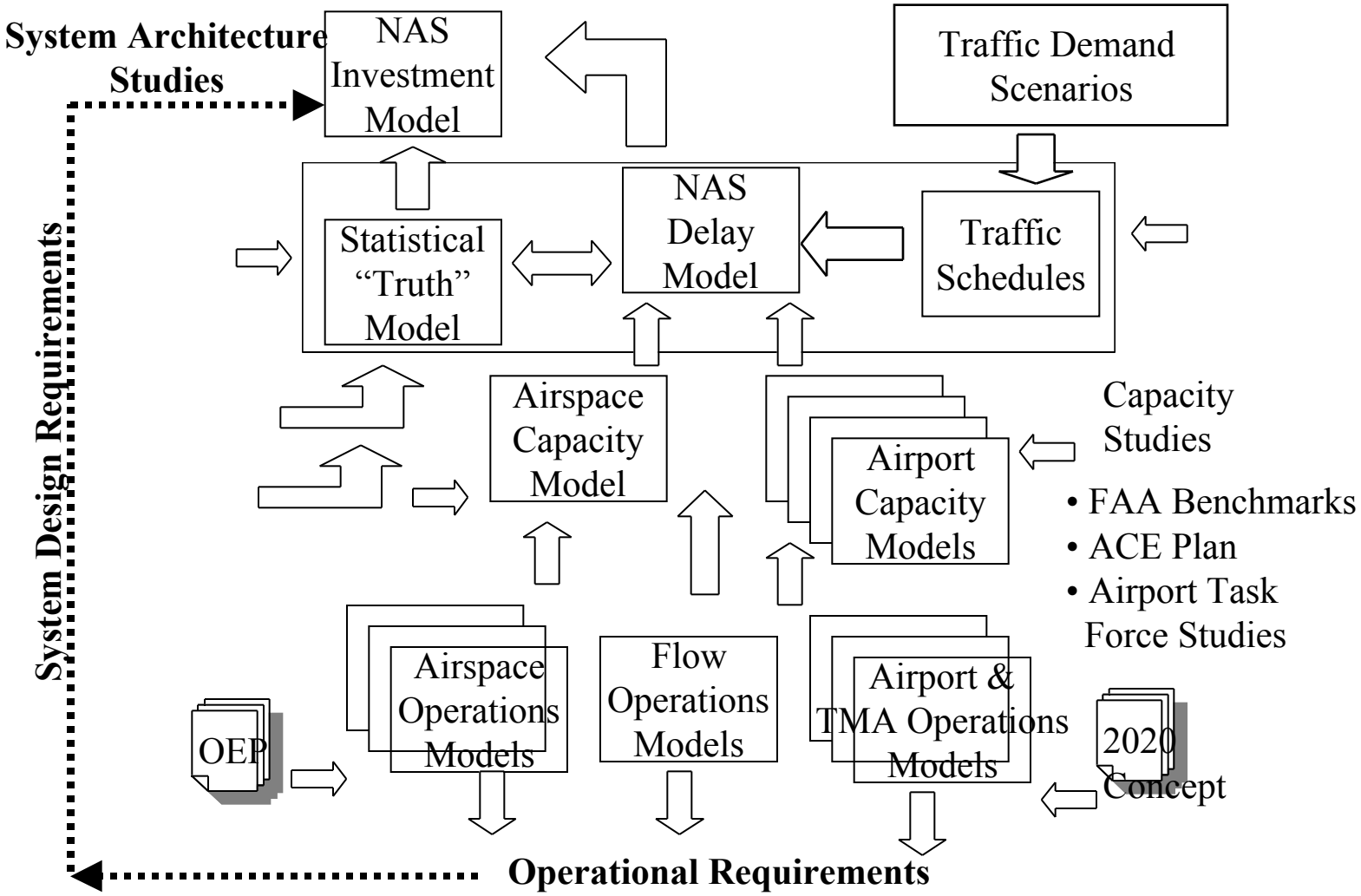
An Airport Example: ORD

Scenario	Optimum Rate	Reduced Rate
Benchmark *	202	160 – 184
OEP *	213	179 – 204
Boeing 2020	285	245
Boeing 2020 Benefit Factors	• Reduced ROT • Improved routing, sequencing & assignment	• Reduced wake vortex separations • Improved routing, sequencing & assignment

* Source: FAA Airport Capacity Benchmark Report 2001



Primary runway
Secondary runway
Optimum configuration
Reduced configuration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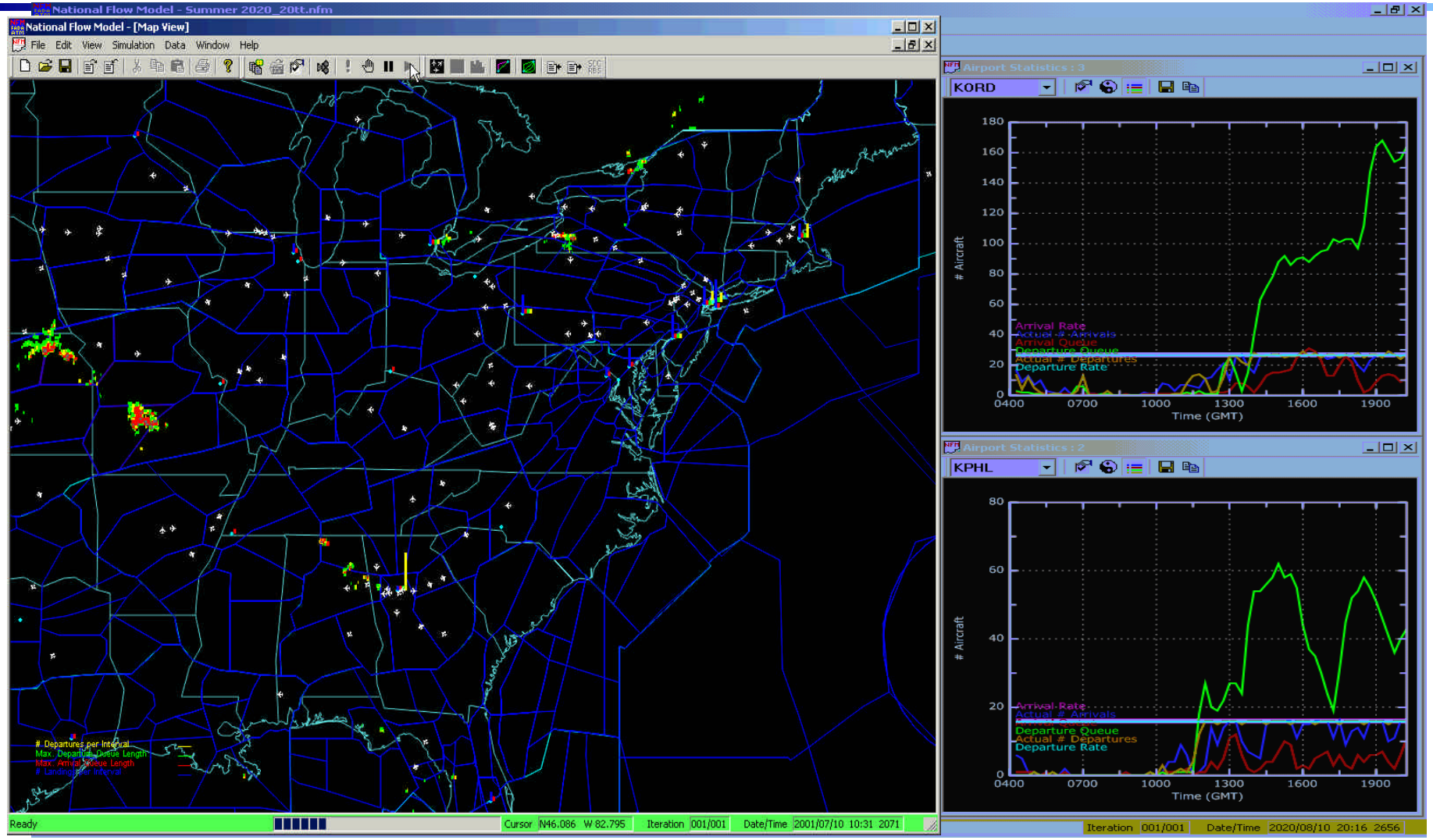
NAS Delay Assessment

- Anchoring
- NAS Delay Growth (Do Nothing Scenario)
- 2020 Alternatives
  - OEP and BATM Concept
  - Throughput sensitivity for ROT changes

Major Airports in the NAS Delay Model



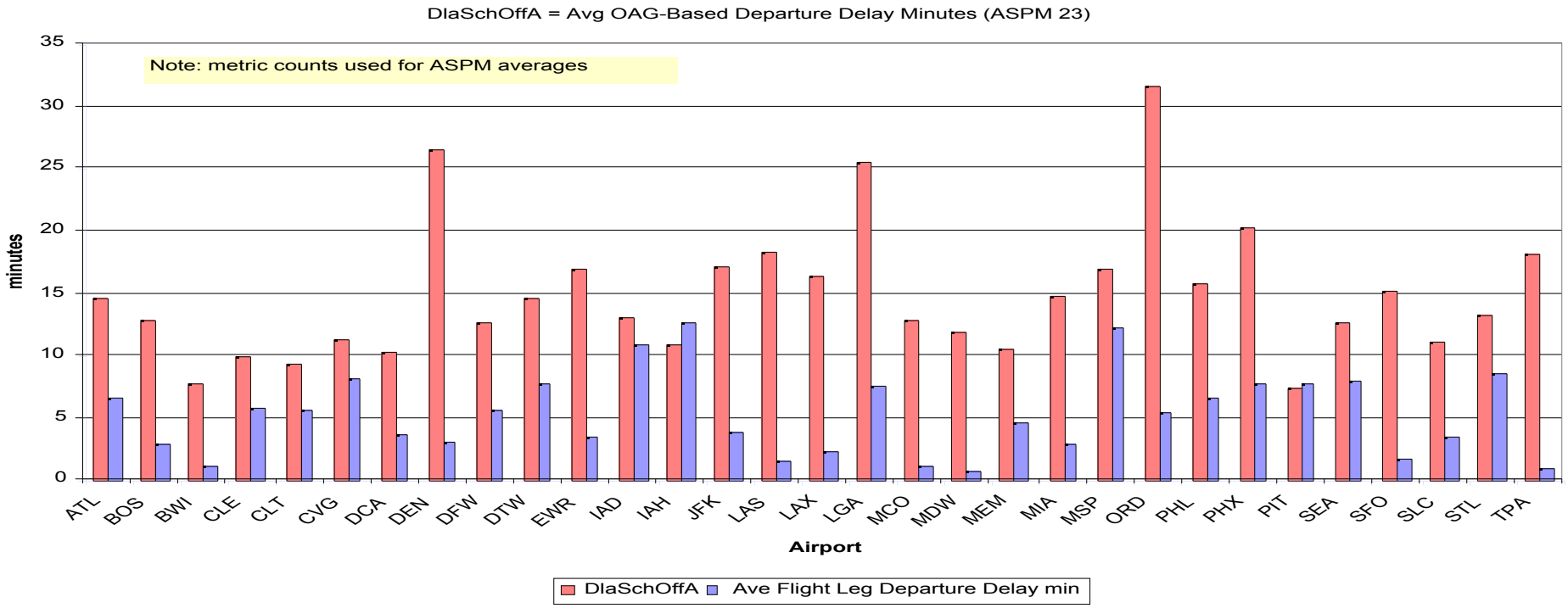
Anchoring of the NAS Delay Model

Comparison of Average Departure Delay from ASPM and NFM

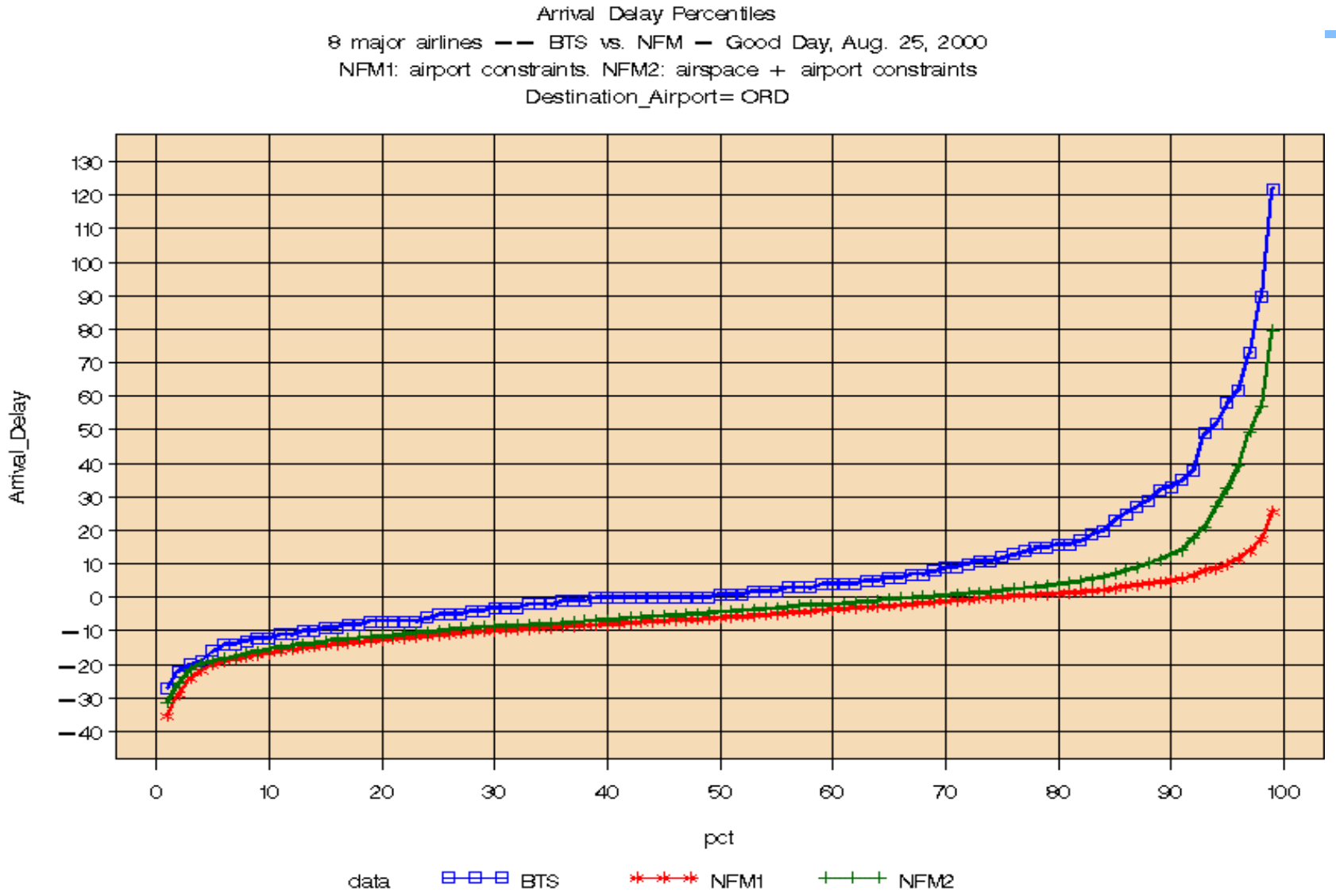
Case 2
072903 apsum

DlaSchOffA (ASPM 23) vs.
Ave Flight Leg Departure Delay min (NFM, Case 2)

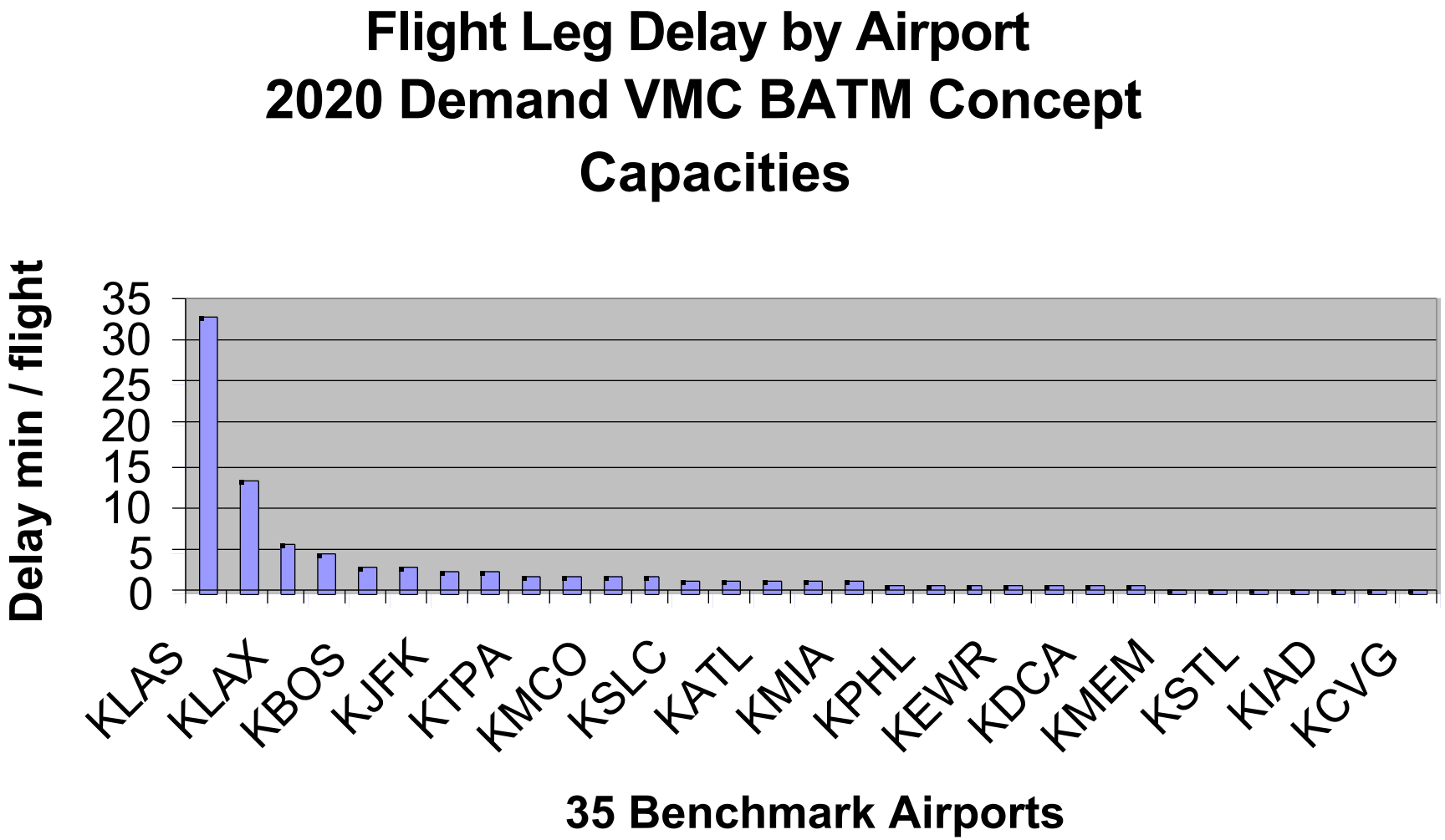
Aug. 25, 2000, 4-23 GMT
Aug. 26, 2000, 0-10 GMT



Anchoring of NAS Delay for a Good Day

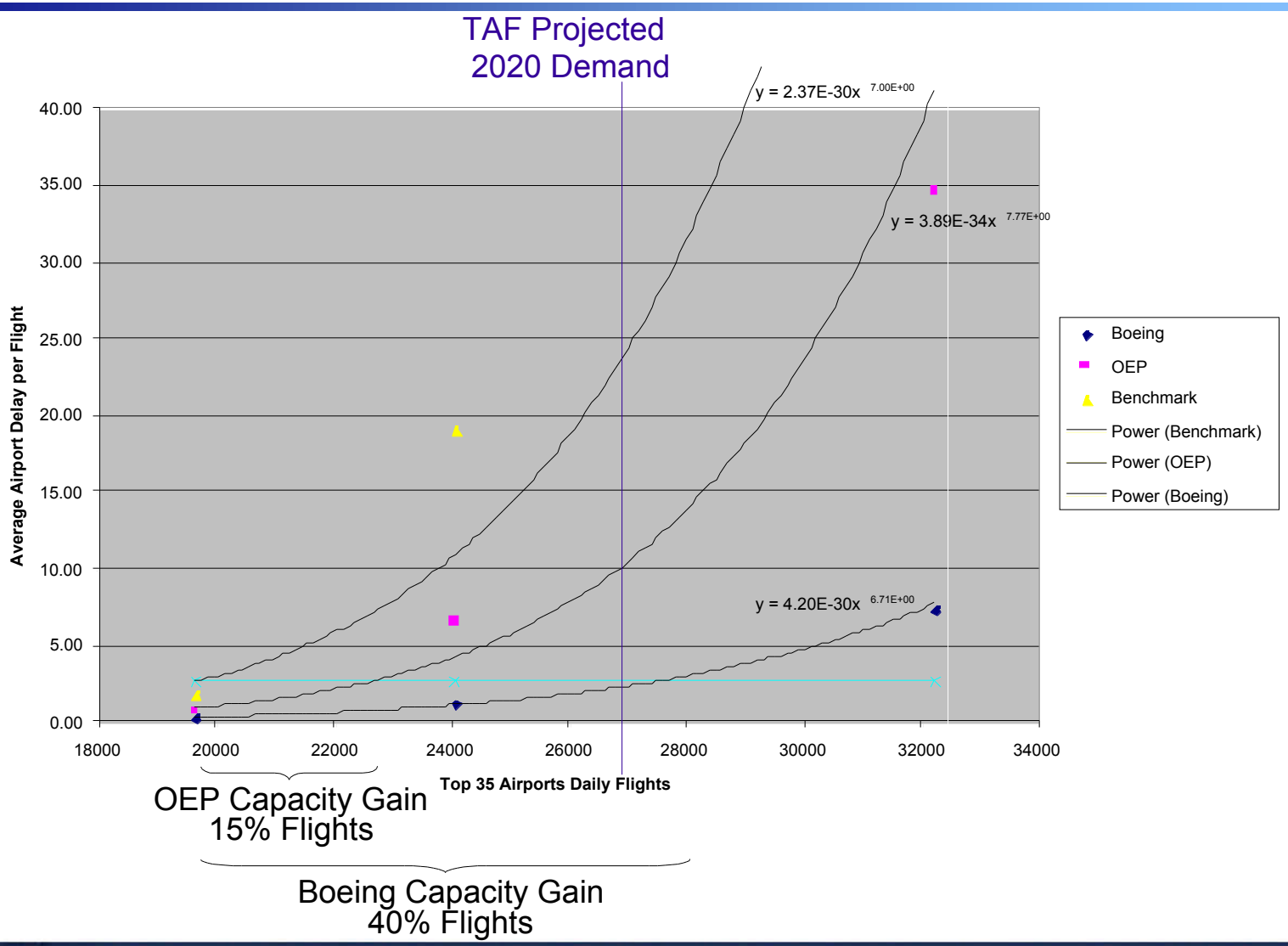


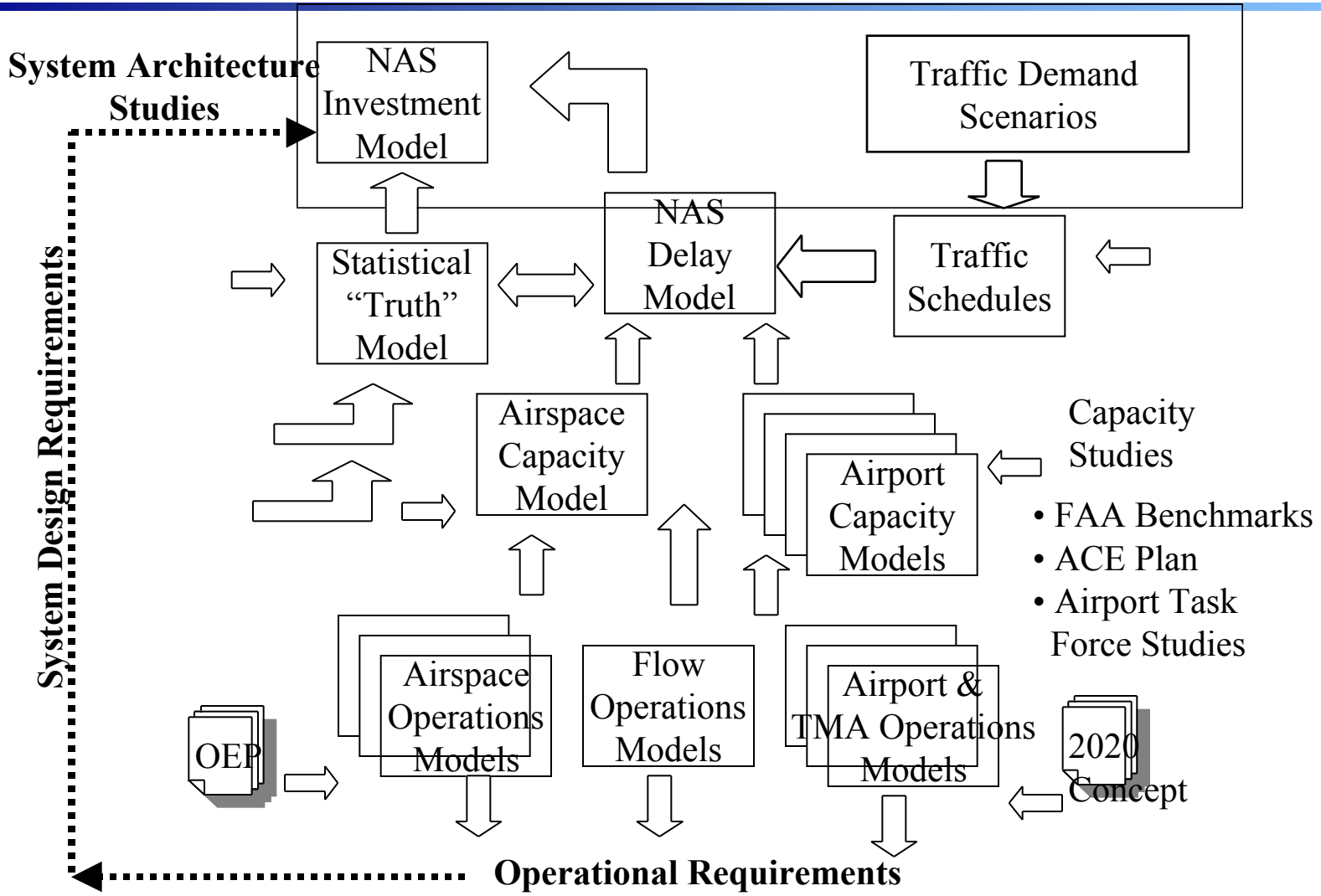
Summary of NAS Delay Results from NFM



Airport Capacity Gains

Top 34 Airports

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Demand Forecast Assumptions

- Demand forecasts assumes:
  - 77% growth in flights from year 2000
  - Same route structure
  - Constrains hourly airport demand to today's VMC capacity + 50%

Investment Assessment

- Assumptions
  - 7% discount rate
  - Benefits start accruing in year 2015
  - Benefits ramp up linearly to full benefits in 2020

- Conclusions
  - The Boeing concept saves 33.6 min/flight in 2020
  - Average annual savings relative to OEP in year 2020 is $11.8B/year
  - NPV of delay benefits relative to OEP in year 2003 dollars is $41B

Study Results and Lessons Learned

- Matured Gate-to-Gate Concept with Time Horizons
- Developed Initial Concept Assessment Methodology
- Developed Concept Self-Assessment Models
- Assessed 40% Capacity Gain Versus FAA OEP 15% Capacity Gain
- Range of Assessment Tools are Needed
- Important to Understand Decision Uncertainty
- Coherent System Data and Metrics Needed

Concept Refinements

- Details of Runway Separation Manager
  - Use of Integrated Planning and Separation Management
  - Use of Trajectory Based Planning
  - Use of Variable Glide Paths for Wake Vortex Protection and ROT Reductions
  - Supports Single and Parallel Runway Operations
- Initial Operational Requirements
  - Runway Separation Manager
  - Convective Weather Response
  - Sector Workload

Challenges & Plans

- Final Phase 3 Plan – Mar 15
- ACES Assessment
  - ACES Design of Experiment – April 15
  - ACES Model Sets – May 15
  - ACES Results Analysis – August 15
- Extend NAS Statistical Calibration – Sept 15
- Delay Model Maturation – Sept 15
  - Add Uncertainty Effects
  - Add Runway and Gate Level Constraints
- Operational and Delay Assessments – Nov 1
- Phase III Evaluation Report – Nov 15
- Concept Document Update – Dec 15
- GFI Model & Scenarios Assessments – Dec 15

Discontinuous change can provide "win-win" breakthroughs

Change the operation to take advantage of new technology