Weather Information supporting the Next Generation Air Transportation System (NextGen)

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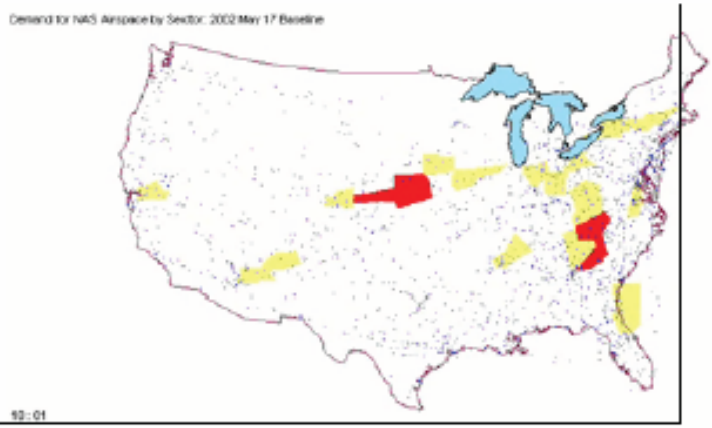
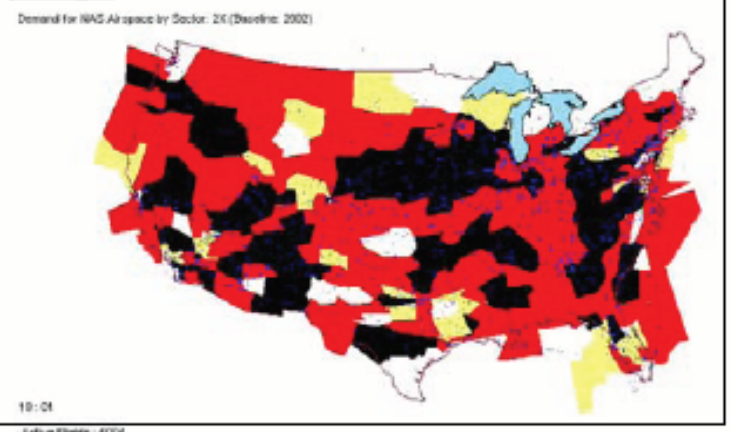
Airspace Loading: Mid-Day EST Demand for Airspace

Snapshot at ~1pm EDT

Baseline Demand (2002)



Future 2X Demand



VAMS ACES Simulation B 2.0.3
Unconstrained Airports & Airspace
250 Airports, 24 hour simulation
Future growth based on Terminal Area Forecast (TAF)

2002: ~27K flights total
Future 2X: ~54K flights total

Sector Color Loading index:

- **Yellow:** 80 – 125% of sector capacity
- **Red:** 125 - 200% of sector capacity
- **Black:** > 200% of sector capacity

Background

- ✓National Civil Aviation Review Commission
- ✓President's Commission on Future of Aerospace Industry
- ✓National Academy of Science
- ✓2003 FAA Reauthorization "Vision 100"
- ✓Senior Interagency Policy Committee
- ✓Joint Planning and Development Office (JPDO)

Vision 100, Public Law 108-176

December 12, 2003

- **Establishes Next Generation Air Transportation System Joint Planning and Development Office**
- **Series of responsibilities**
  - **Create and carry out "the Plan"**
  - **Coordinate goals, priorities, and research activities within Federal Government and across US aviation industry**
  - **Facilitate technology transfer from research to operational and private sector organizations**
  - **Review activities related to environment and safety**
- **Operate in conjunction with relevant programs in specified government agencies**
- **Consult with the public and ensure the participation of experts from a broad range of entities within the private sector**

Interagency Governance

Senior Interagency Policy Committee

- Guides and approves the Integrated National Plan
- Chaired by the Secretary of Transportation

Joint Planning and Development Office (JPDO)

- Develops and oversees implementation of the Integrated National Plan

Interagency Integrated Product Teams

- Develop and oversee implementation of Action Plans

Integrated National Plan (The Plan)

- Established National Goals
- Set context for Transformation
- Set direction for Transformation (8 Transformational Strategies)
- Created governance model for multi-agency cooperation
- Delivered to Congress in December, 2004

2025 NexGen Concept

Operating Principles

- **"It's about the users…"**
- **System-wide transformation**
- **Prognostic approach to safety assessment**
- **Globally harmonized**
- **Environmentally compatible to enable continued growth**

Key Capabilities

- **Net-Enabled Information Access**
- **Performance-Based Services**
- **Weather-Assimilated Decision Making**
- **Layered, Adaptive Security**
- **Broad-Area Precision Navigation**
- **Trajectory-Based Aircraft Operations**
- **"Equivalent Visual" Operations**
- **"Super Density" Operations**

Key FY06 JPDO Products

(“Expert” and Architecture Based)

- NGATS Vision (2025 Concept)
- Capabilities and Outcomes

- Early opportunities (FY07*)
- Agency guidance (FY08*): implementation & research
- Segment portfolio (FY08-12*) with consolidated business case
- 2025 benefits assessment*
- Demonstrations (e.g. NEO*)

- Concepts of Use
- Concept of Operations
- Enterprise Architecture
  - 2025 and intermediate architecture versions
  - “Executable architecture” (models and simulations) for evaluation and analysis

- Policy formulation and advocacy
- Progress tracked towards NGATS goals and objectives
- Progress report to Congress

* Denotes “Expert” Based

Weather IPT Background

- JPDO Weather Group – started in 2003
  - Core group of 20+ experts from Government and industry worked on the early NextGen weather vision
- In 2005 the early group formed the Weather IPT bolstered by 130+ more sub-team participants on a part-time and voluntary basis
- Rationale for Weather IPT is two-fold
  - Create a true multi-agency national plan for aviation weather – mitigate the fragmentation and “stove-piping” of aviation weather programs across federal agencies
  - Develop, promote, and implement NextGen weather vision

Weather IPT Structure

Sub Team Responsibilities

Observations

- Inventory existing programs
- Conduct trades/cost-benefit analysis
- Align programs to support IPT vision
- Determine optimum mix of space-, airborne-, and ground based observation systems
- Review/update observation policies

Forecasts

- Develop NGATS requirements
- Inventory existing programs
- Conduct trades/cost-benefit analysis
- Align programs to support IPT vision
- Prepare and implement forecast roadmap supporting delivery of probabilistic gridded information

Dissemination

- Develop NGATS database requirements
- Inventory agency/industry efforts
- Prepare and implement roadmap designed to deliver national weather information network by 2012, with probabilistic capability by 2015
- Work closely with AATS and SA IPTs

Integration

- Develop NGATS requirements
- Inventory existing programs
- Conduct trades/cost-benefit analysis
- Define and document system interfaces (ICD)
- Create and implement govt/industry roadmap for weather decision support tool development

Training

- Evaluate agency aviation weather training activities
- Develop and implement policy and procedures to provide weather training for each NGATS decision maker
- Institutionalize weather training and orientation visits to enforce understanding of opertional needs
- Evaluate need for NGATS proficiency requirements

Mitigation

- Define aircraft specific transformation needs and requirements
  - Turbulence
  - Icing
  - Synthetic Vision
  - Gust Alleviation
  - Vortex Suppression

Policy and System Engineering Sub Teams not shown

Aviation Weather History and Current State

- Safety – has been the driving force behind aviation weather
- 80's and 90's were renaissance era for advancing the state of the art in aviation weather from safety perspective
  - Dramatic decline in weather related aviation fatalities have resulted from
    - Improved detection and forecast of hazardous weather
    - Real-time broadcast of local conditions
    - Exploitation of satellite and NEXRAD imagery
    - Deployment of warning systems like LLWAS, TDWR
    - Better understanding of in-flight icing, how to predict it, and how to detect it
- 80's and 90's also saw dramatic increases in summertime delays due to weather as air traffic levels rose
- **Bottom line: The NAS as a result of past aviation weather research and system development has become much safer, however there has not been a noticeable improvement in weather impacted capacity**

Weather IPT Assessment of Aviation Weather

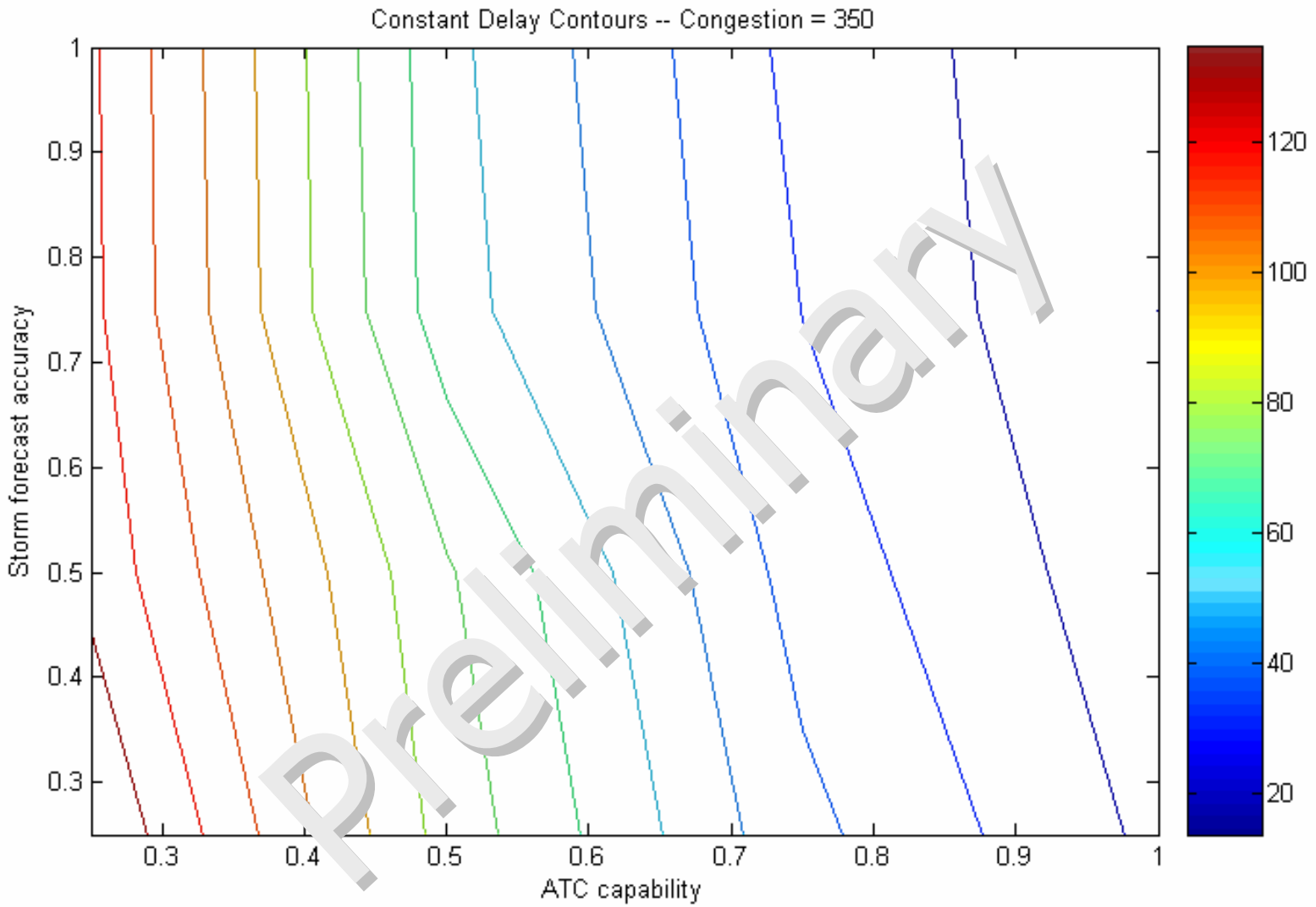
- **Advances in aviation weather products and information are not effectively utilized by the NAS**
  - **Technology transfer from research to operations is slow due to lengthy safety reviews and lack of funding and FAA platforms' inflexibility**
  - **Operational NAS end-users, particularly FAA users, have not actively participated in defining research requirements**
  - **Little emphasis placed on information dissemination and related training on the use of the new information**
- **Improvements to current NAS weather performance will require cultural and operational paradigm shifts in total system behavior with respect to weather information**
  - **Many weather related operational regulatory policies are in need of review and updating**
  - **Preliminary research results indicate information reliability may be more important than accuracy**
  - **Some improvement may not be realized until a M2M concept is deployed**
- **Where is the balance between the needs of today versus the needs of tomorrow?**
  - **"Quick fix" answers solving today's problems limit degrees of freedom for tomorrow's systems**

Weather IPT Assessment of Aviation Weather (Concluded)

- Significant policy issues remain
- The NextGen weather system may not require “new” money
  - Existing funding profiles across the agencies, if properly leveraged, could implement the new system
- Convection forecasting research and development lacks focus, while it remains a high priority

(Russ Chew (FAA COO): "The JPDO can come up with the best ATM automation system on the planet, but if we don't figure out how to improve our handling of weather, summertime convection will eat our lunch every year and it will only get worse as traffic grows." - February 22, 2006, at ATCA)

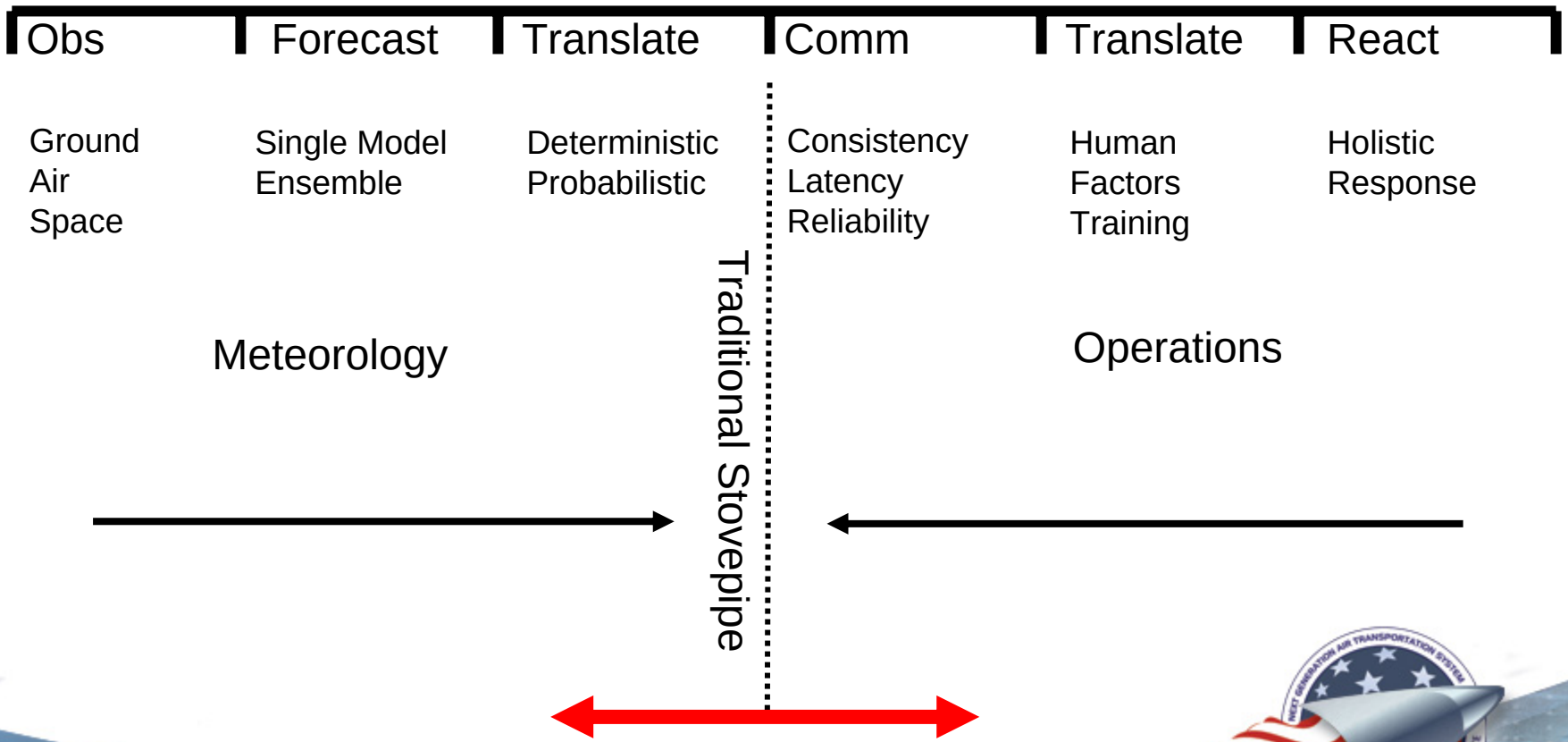
Investment Analysis



The Foundation: Premise of "The Perfect Forecast"

- Current state of atmosphere must be perfectly measured (observations)
- Observations must be perfectly blended into a perfect representation of current state
- Forecast models must perfectly predict future state given current state
- Forecast prediction must be perfectly communicated
- Forecast prediction must be perfectly understood
- Reaction to forecast must be consistent

Perfect Forecast Process



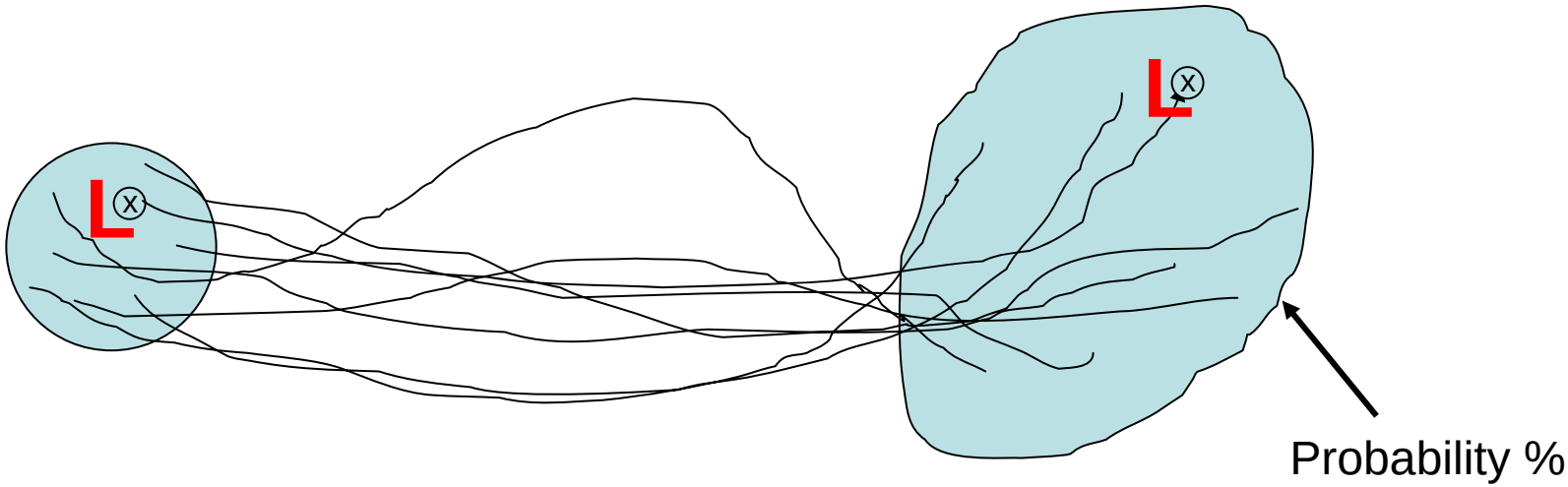
Advances in meteorology

- 1920's Frontal theory
- 1940's Upper Air Observations
- 1960's Weather Satellites
- 1980's Numerical Weather Prediction
- 2000's Ensemble Prediction Systems

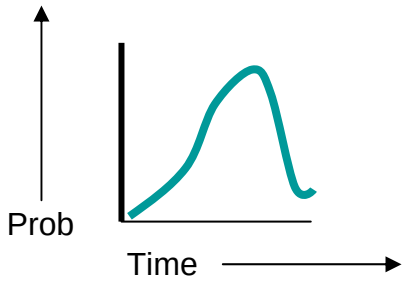
A weather equivalent of "Moore's Law": Roughly every 20 years a transformational increase in capability has been achieved

Ensemble Prediction Systems

Meteorology through the year 2000



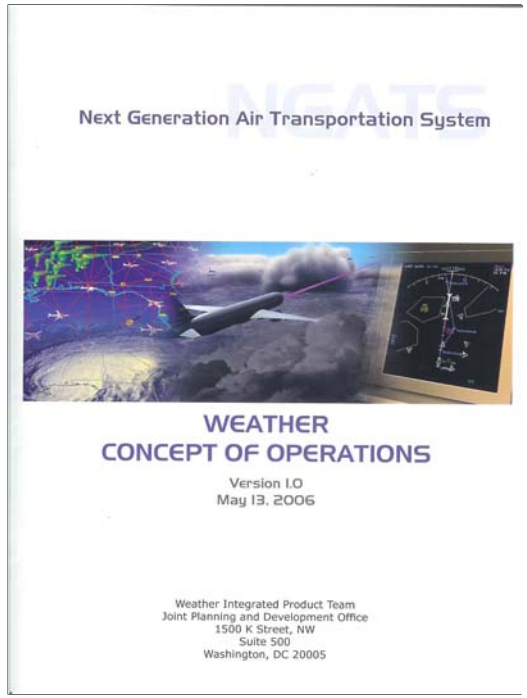
YES/NO



For any X,Y,Z,T (4D)

NGATS Weather Vision

- **Common Weather Situational Awareness**
  - **NextGen Network Enabled Weather (NNEW)**
  - **Capitalize on NextGen Network Enabled Operations concept**
  - **“Single authoritative source” for NGATS decisions**
- **Make weather “transparent”**
  - **Information becomes the “product”**
  - **No stand alone weather systems**
  - **Weather is fully integrated into NextGen decision cycles**



NGATS Weather Vision
What's the difference?

- **Fully capitalizes on NextGen Network Enabled Operations concept**
  - **Previously limited capability for communications bandwidth forced local weather solutions**
- **Does not require end-to-end product development**
  - **Promotes better application of resources / expertise**
  - **Total weather system costs go down (significantly)**
  - **Brings together private / government weather capabilities**
- **Changes several weather paradigms**
  - **Weather information accuracy is not the primary factor**
  - **Role of the meteorologist**
  - **Information becomes the product; product types and displays are almost limitless and can be tailored to the supported mission with much greater ease**
  - **Weather displays become obsolete**
  - **NextGen proactive behavior with respect to weather information has significant total system performance payoff**

Weather IPT Overall Recommendations

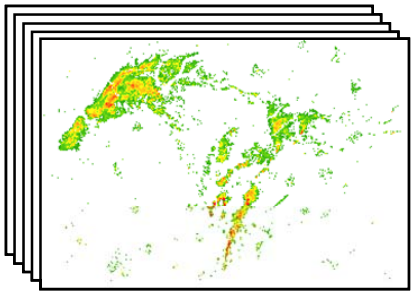
- **Establish a national-level aviation weather oversight function – (Note: not necessarily the weather IPT)**
- **Develop and implement a national level weather information dissemination strategy—taking advantage of envisioned NextGen NEO capabilities**
- **Form a cross-agency NNEW program office**
- **Judiciously realign and restructure selected weather programs to simplify, and accelerate benefits, within existing resource levels**
- **Develop strategies to improve and seize opportunities in training of controllers and traffic flow managers in their understanding and use of weather information**
- **Align wake vortex efforts with the NGATS vision to allow better leveraging of wake vortex investments**
- **Identify leveraging opportunities within the surface and marine transportation communities of interest**

Weather IPT Current Focus

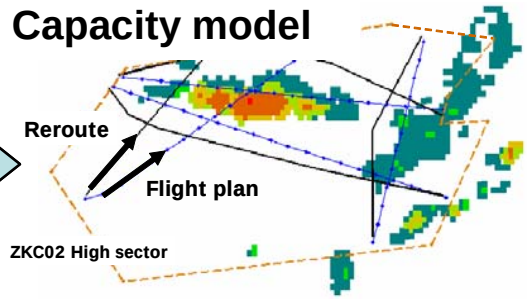
- **Develop NextGen weather research and implementation requirements**
- **Collaborate with other JPDO IPTs towards NNEW vision**
  - **A national virtual aviation weather information system is technologically feasible and could eliminate the need for standalone, domain-centric data processors and the applications that run with those programs**
  - **Lessons learned are readily available -- DoD has net-centric weather handling strategies in various stages of maturity. NWS, FAA, and DoD can complement each other's programs to make more progress faster and reduce total system cost**
  - **NNEW becomes a major enabling capability to allow NextGen "weather agility", which is the biggest paradigm shift (System is proactive vice reactive to weather information)**
- **Define 2012 "Spiral 0" requirements for NNEW**
- **Facilitate creation of NNEW program office**

Probabilistic NAS Capacity Forecasting

Nowcast database

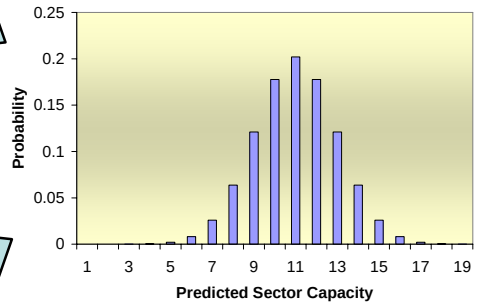


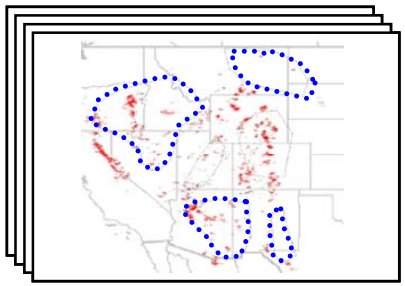
Capacity model



Actual capacity

Capacity PDFs





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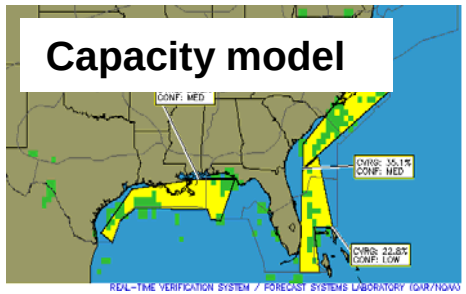


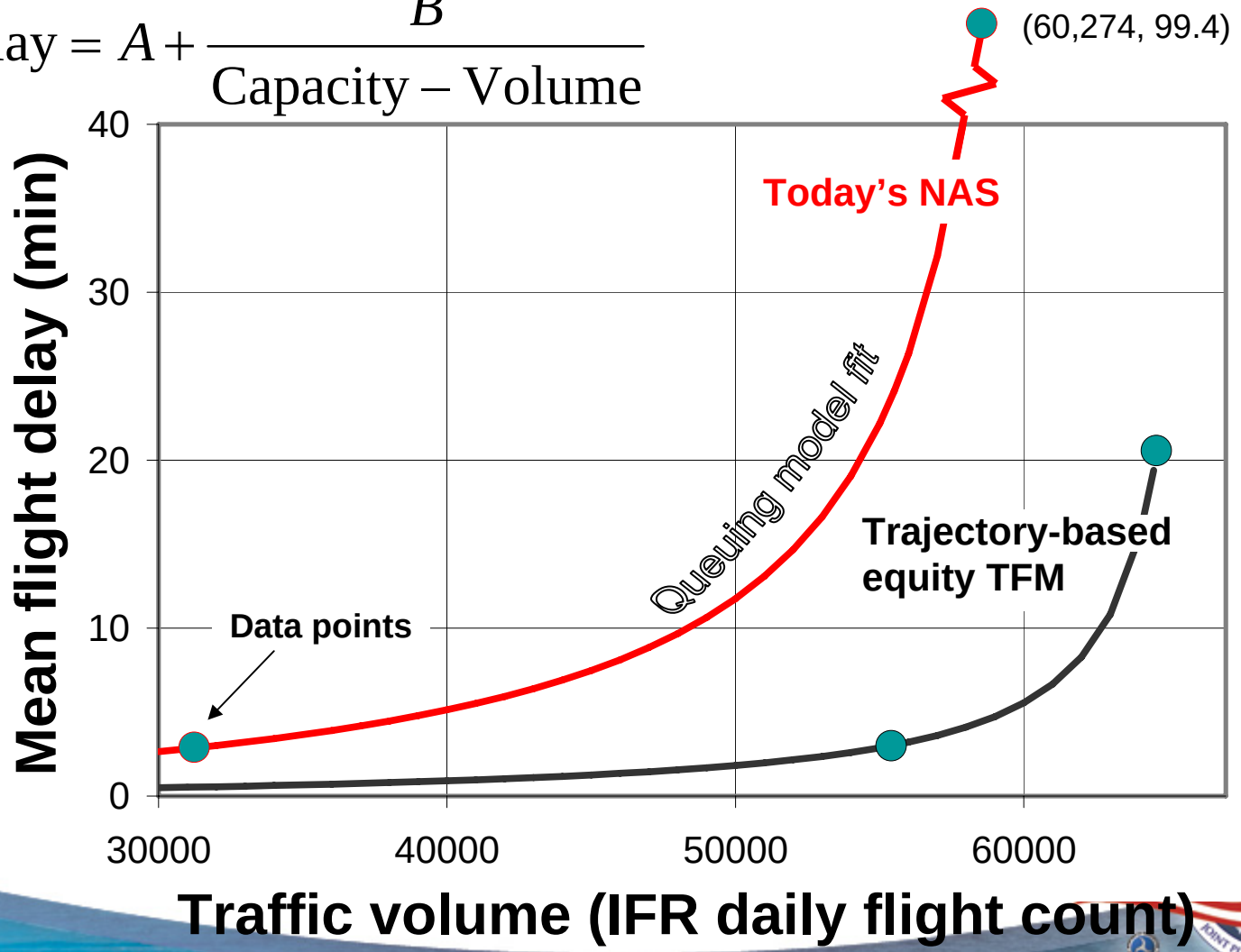
Forecast capacity

Forecast database

4D “Datacube”

System Capacity – Queuing Delay

$$\text{Delay} = A + \frac{B}{\text{Capacity} - \text{Volume}}$$



Questions?

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