Quantifying Convective Delay Reduction Benefits For Weather/ATM Decision Support Systems

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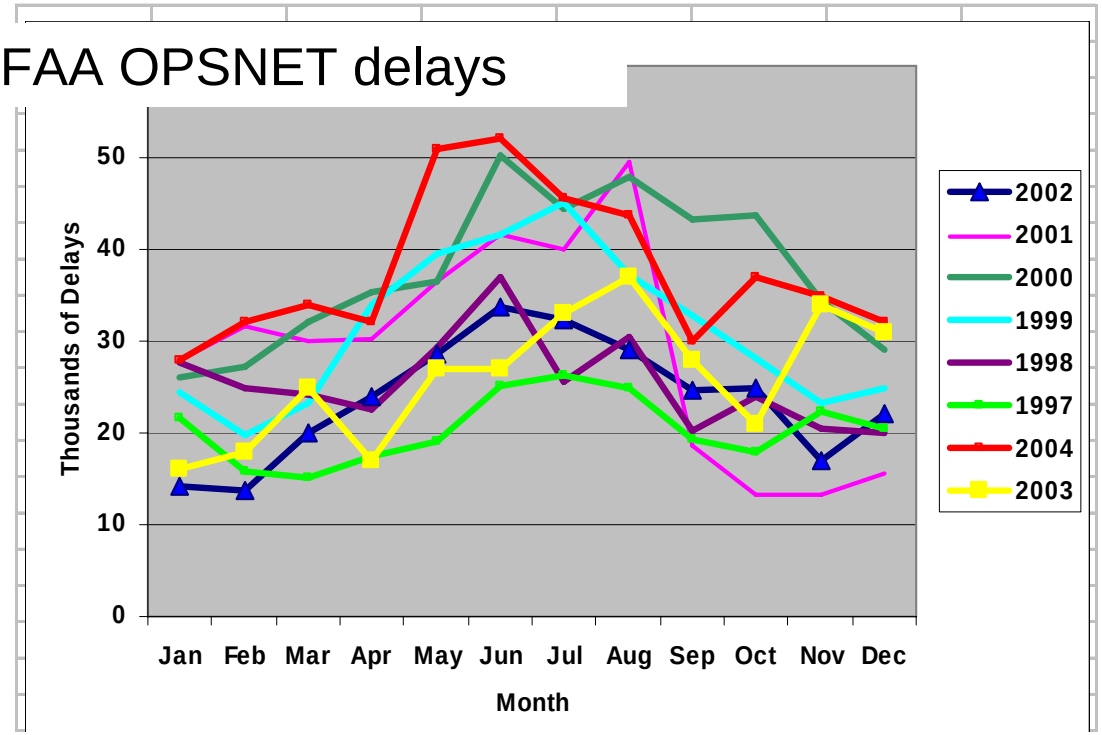
Outline

- Motivation for work
- Conceptual framework for US aviation system operations in convective weather
- Benefits assessment approaches
  - User decision data acquisition/modeling as accomplished for the Corridor Integrated Weather System (CIWS)
  - Delay statistics comparisons – the Atlanta ITWS experience
- Recommended future approach
- Summary

Motivation

- **Increased emphasis on metrics for system performance and investment decision making by ATO, FAA customers and, OMB**

- **Convective weather season is a principal cause of delays in US system**



- **Many ATM and weather decision support systems are involved in reducing convective weather delays (TFM-M, CIWS, ITWS, URET….)**

Key Elements of Benefits Analysis

- Understand delay generation mechanism
- Capability of candidate measurement tools
  - Observations of use of system by operational users
  - Delay statistics: ASPM, OPSNET
  - Aircraft data: ETMS, plane reports
  - Weather data: METARs, Weather radar data, lightning
- Develop and validate approach to making measurements on system to see if expected effect :

  reduction of the delays that would have occurred without the system under test

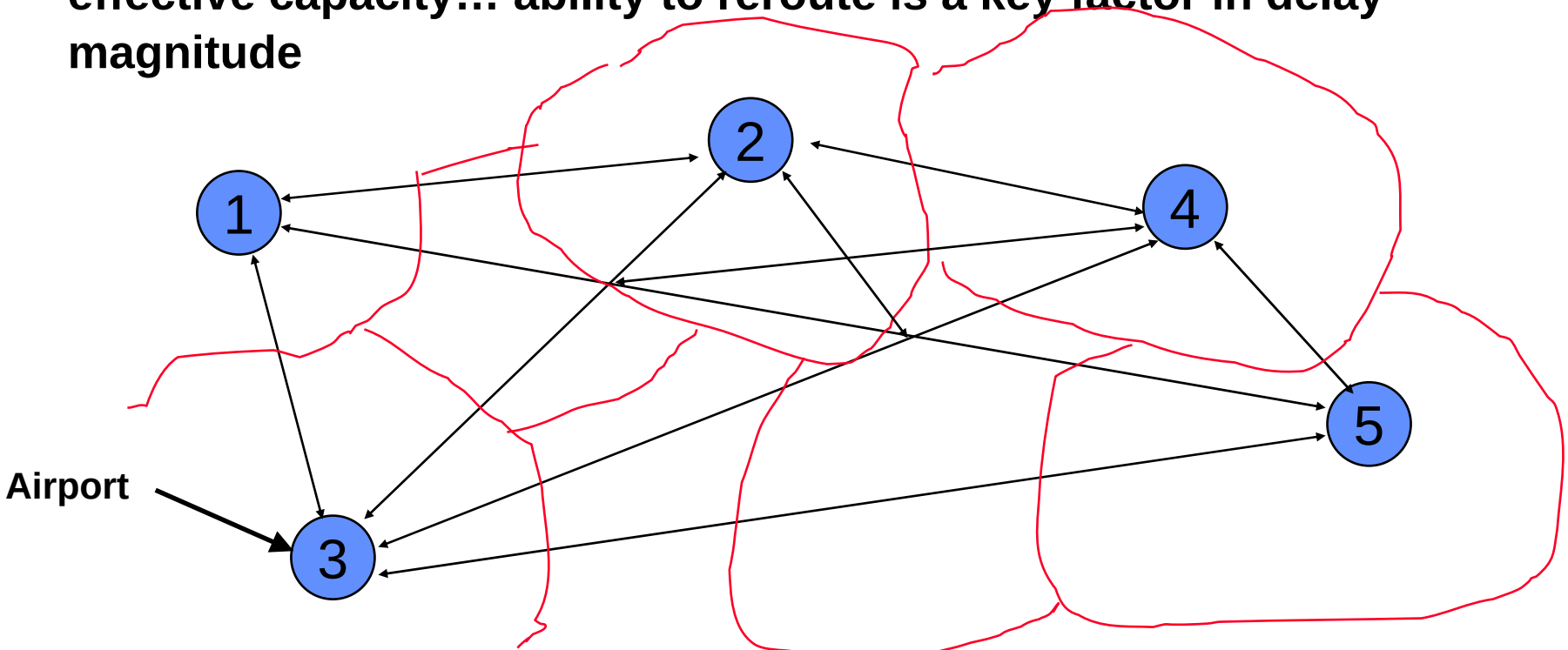
  is present and, estimate the magnitude of the delay reduction

What is Generating the Delays: NAS Network Constraints

Paradigm A: Insufficient adverse weather capacity at airports

Paradigm B: Storms impact the network by reducing the capacity of jet routes, en route sectors and terminals.

Bad delay days invariably involve en route and terminal demand > effective capacity… ability to reroute is a key factor in delay magnitude



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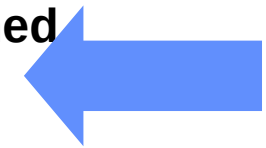
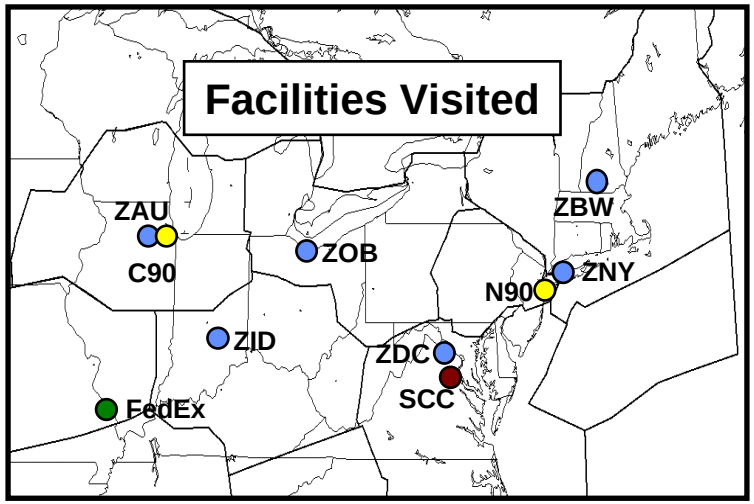
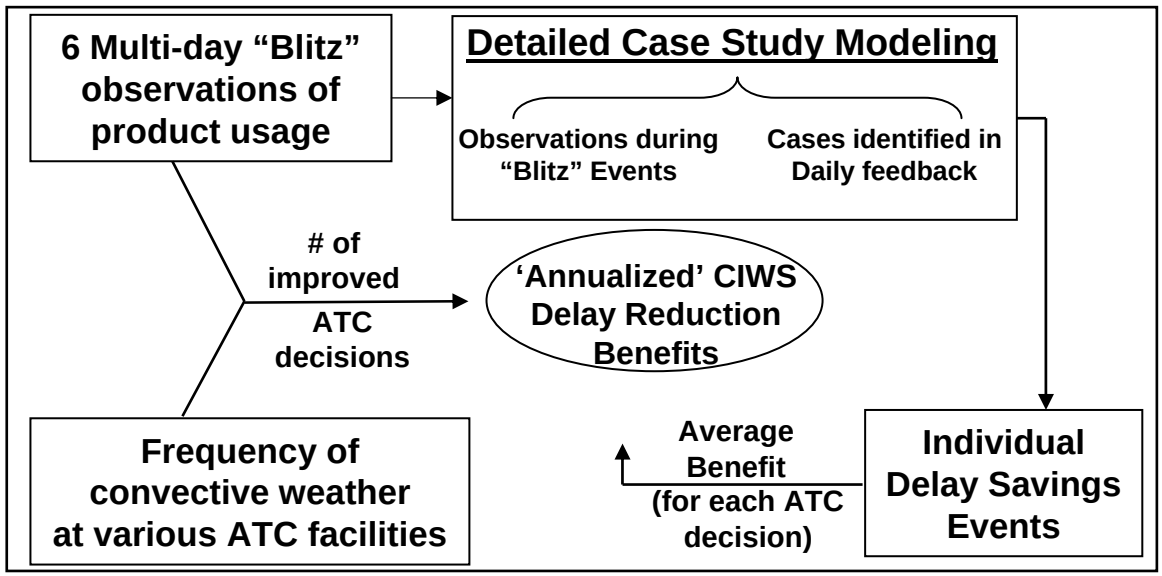
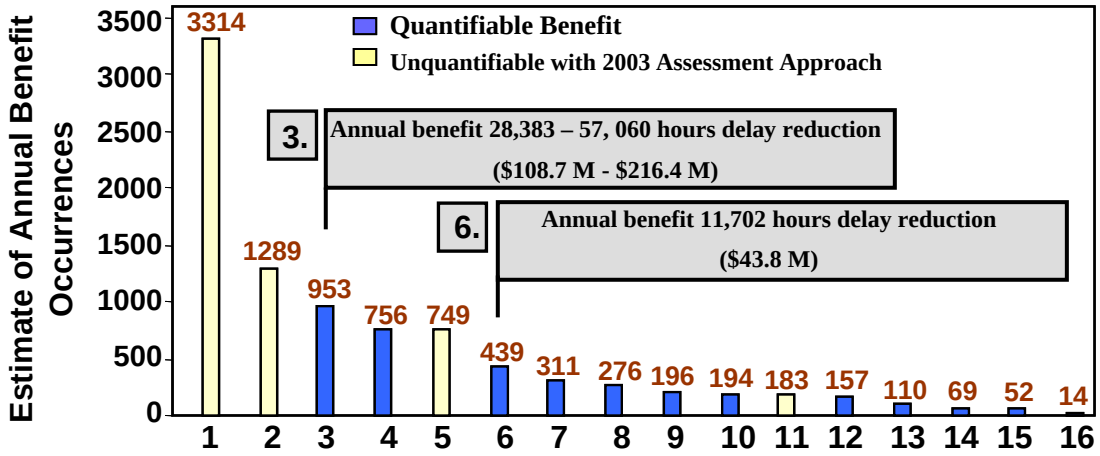


2003 CIWS Benefits Approach

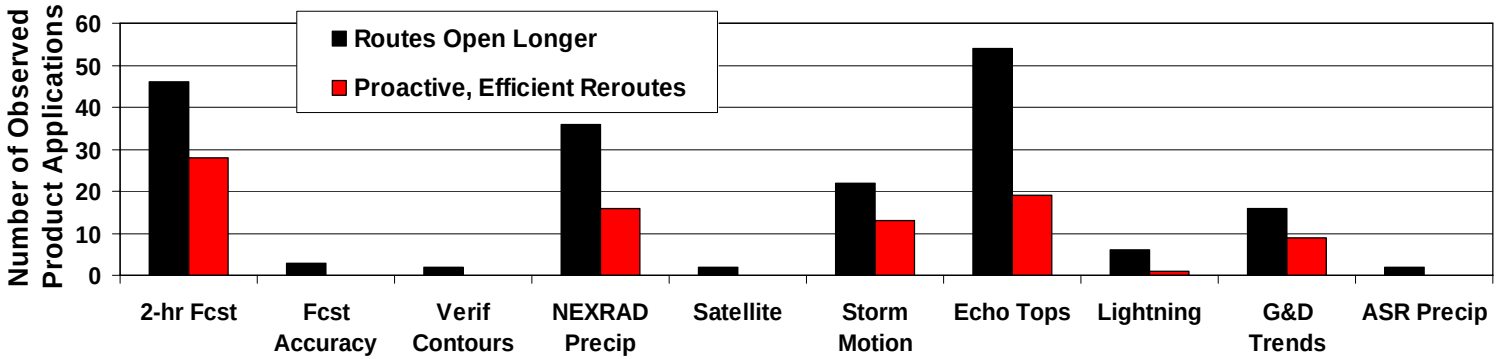




CIWS Domain Delay Benefits in 2003



1	Situational awareness	9	Shorter/fewer ground steps
2	Interfacility coordination	10	Directing traffic through gaps
3	Routes open longer	11	Improved safety
4	Improved Arrival Transition Area (ATA) management	12	Close route proactively
		13	Optimize runway usage
5	Reduce workload	14	Avoid ground stop
6	Proactive reroutes	15	Reduced MIT restrictions
7	Directing pathfinders	16	Improved use of Ground Delay Program (GDP)
8	More SWAP departures		



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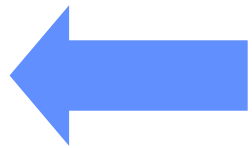


Weather Data for Assessing Convective Weather Severity

- Surface observations
  - Good for ceiling/visibility and runway winds
  - Very limited detection range (7 nmi) for thunderstorms
- Cloud-to-ground lightning strokes
  - Clearly demonstrate presence of convective weather (no AP)
  - Do not appear in operationally important growth phase of storms
  - Show poor statistical correlation with pilot decision making on storm penetration versus deviation (LL studies for NASA)
- Weather radar (e.g., NEXRAD) data
  - High quality 3D data shown to correlate well with pilot decision making
  - Hard to work with (infra structure expensive)
  - Many readily available data sets (ETMS, NCWD, CCFP validation) have major quality problems (e.g., inaccurate reflectivity, inaccurate or no echo tops, AP contamination)

ITWS Benefits Assessment by ASPM Delay Statistics at Atlanta

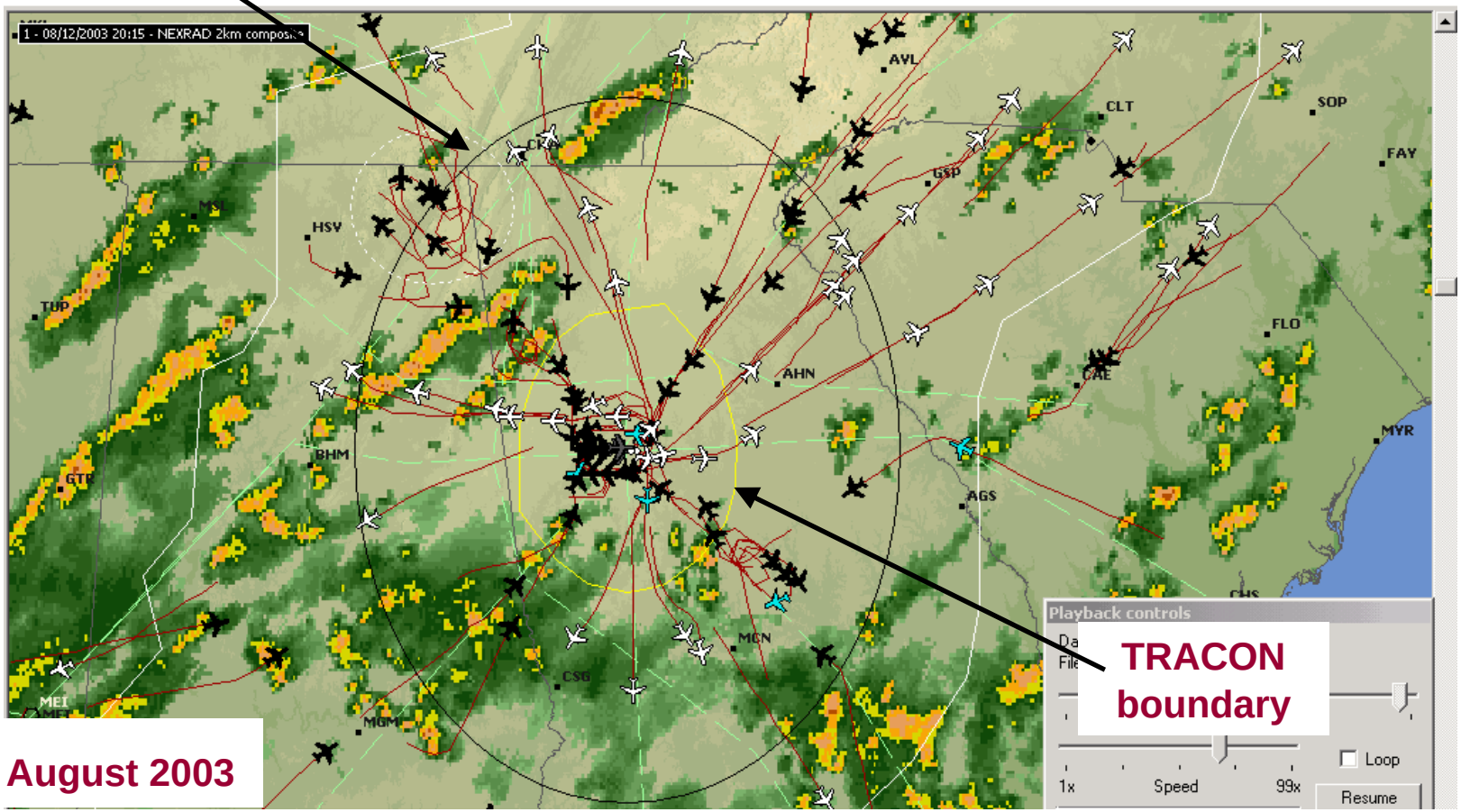
- ITWS installed in 2002; sought to compare ASPM delay statistics between 2001 and 2003
- Approaches used to isolate convective weather impacts
  - Focus on METAR thunderstorm (TS) observation days
  - Periods of a few hours around a METAR TS observation
  - ASPM flight times 100 nmi to touchdown

  all had problems
- Delay difference results were very sensitive to small changes in delay metric and period of presumed storm impact
- Convective weather potential to cause delays was very different between two years even though # of thunderstorm days were identical
- Hard to assess the benefits for other systems tested at same time (CTAS)

Examples of Atlanta ASPM Analysis Problems

METARs as an indication of weather: There was never a thunderstorm observation at ATL on this date

100 nmi from ATL



12 August 2003

Delays for aircraft holding > 100 nmi from ATL were not captured by ASPM

Assessment of Individual System Benefits

- Use intensive facility observations during convective weather plus detailed analysis to focus ASPM delay statistical analysis
  - Analyze specific situations in relatively small spatial regions to minimize other factors and, make it easier to find comparable weather impact events
  - Look in detail at flight tracks and weather radar data as opposed to relying only on surface observation reports (METARs) to characterize convective weather impacts
- Develop weather severity impact metrics that capture the key NAS structural features including queues
- Finding comparable convective weather delay cases to analyze may be difficult for systems that cover wide regions (e.g., CIWS)

Summary

- Convective weather continues to dominate overall NAS delays and, causes large unexpected delays that are particularly disruptive to the FAA's customers
- Policy changes make it critical to assess whether the NAS is managing convective weather better
- Assessment of performance is challenging
  - Convective weather events are not repeatable
  - Many other factors (TFM, procedures, demand) impact delay
- User feedback plus detailed observations and data analysis has been effective as an assessment tool; but FAA and OMB are seeking delay statistics based approaches
- Need a NAS structure specific approach to characterizing weather severity in which en route and terminal capacity are explicitly considered