Next Generation Air Transportation System: Meeting the Enterprise System Engineering Challenges

Gerald Friedman (MITRE)
Catherine Bolczak (MITRE)
Robert Humbertson (MITRE)
John Mack (MITRE)
Jay Merkle (FAA)

25 October 2007
Pressure from Growing Traffic Congestion and Airline Delays

The New York Times

Flying the Crowded Skies: Challenges for Aviation

By MATTHEW L. WALD
Published: January 15, 2007

WASHINGTON, Jan. 14 — By 2025, government experts say, America’s airports will be three times as many planes, and not just the kind of traffic flying today. That of tiny jets, eating up air space, as airliners redesign, competing for space and drones that need help avoiding midair collisions, and with commercially carrying satellites and tourists into space.

The Wall Street Journal

July 21, 2007
HOT TOPIC

Why the Skies Have Gotten Crowded

By SARAH NASSAUER

Data this past week validated what many fliers already suspected -- the number of delays and cancellations in June may have been the worst ever. According to FlightStats.com, 20,300 flights were canceled in the U.S., more than double the number grounded in June 2006. Among the 40 largest U.S. air carriers, more than 50% of flights scheduled to land in the U.S. arrived late.

Aviation Week & Space Technology

Record Delays Loom

Summertime and the traveling won’t be easy in the U.S. National Airspace System

By Alan Levin

Airline delays in recent months have been caused by poor weather, the high volume of air traffic at many airports and a limited supply of air traffic controllers.

The Wall Street Journal

July 17, 2007

Why Fliers Find Summer Travel Growing Tougher

By SCOTT MCCARTNEY

Number of Cancellations

More Than Doubles

Amid Storms, Gridlock

Aviation Week & Space Technology

TIPPING POINT: passengers
Pressure from Delays and Cancellations on Airline Quality of Service Standards

The Washington Post
Flying Late, Arriving Light
Air Carriers Are Delaying More Flights and Losing Your Shirts

The Atlanta Journal-Constitution
Congress eyes standards for airline service
By BOB DART
The Atlanta Journal-Constitution
Published on: 04/02/2007

Washington — Airlines have not kept their promises to protect passengers from delays and cancellations, so Congress may need to set federal standards for customer service, Transportation Department investigator told a House subcommittee Friday.

The New York Times
Federal Agency Investigating Airline Arrival-Time Promises
By JEFF BAILEY
Published: April 21, 2007

The Transportation Department said yesterday that it was investigating several domestic airlines for publishing unrealistic flight schedules — including ones that list arrival times the carriers know they cannot achieve — and said as many as eight could be fined for failing to provide accurate flight-delay information.

The Wall Street Journal
February 6, 2007
THE MIDDLE SEAT
By SCOTT MCCARTNEY
A Report Card On the Nation's Airlines
Despite Financial Recovery, Many Carriers Still Plagued
By Spotty Customer Service

H.R. 1303
Passenger Bill of Rights

To amend title 49, United States Code, to improve air carrier passenger services.

110th CONGRESS 1st SESSION
IN THE HOUSE OF REPRESENTATIVES
FEBRUARY 6, 2007

WASHINGTON, D.C.

"To amend title 49, United States Code, to improve air carrier passenger services."

1. Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,
2. SECTION 1. SHORT TITLE.
3. This Act may be cited as the “Airline Passenger Bill of Rights Act of 2007”.
4. A BILL
5. To amend title 49, United States Code, to improve air carrier passenger services.
Pressure from Airlines on ATM System Performance

Delta Takes Steps to Mitigate Impact On Customers as Severe Weather Approaches Northeast

Delta Urges Congress to Modernize Air Traffic Control System

Airlines Attribute Delays to Poor Traffic Control

THE WALL STREET JOURNAL
July 21, 2007
REVIEW & OUTLOOK

Gridlock in the Air

No one who has traveled by plane recently needs to be told that our commercial air travel system statistics support the anecdotal evidence of crowded airports, hourlong lines to get through security and more than 30% of all flights were delayed. It's enough to make you think twice about every departure time.

Not that we're not sure that firing Mr. Blakely -- who is Chuck Rafferty, not Chuck Blakely -- would be any more effective. Mr. Blakely is anyone who will listen to fix some of the problems with the air travel scene, but this summer's delays put the overworking in the headlines and on the floor with the air-traffic controllers union, which has placed her on the heart of a number of Democratic politicians, including New York's Senator Hillary Clinton.

The increasing cost (at least 2% between 1998 and 2003) hit the FAA with less and less on modernization projects that might actually alleviate some of the problems and "counterproductive," as Mr. Schumer claimed. Mr. Blakely's victory over Obama's step toward getting the air-travel system back on track.

He really wants to do some good for New York's airports, though, but he might think of the Connectors. The delays in New York and around the country are not a tendency to become tangled in the competing interests of New York's, "To err is human, and when you combine those with Washington partisanship, the results are disastrous.

The three main New York-area airports that Mr. Schumer is concerned about New York, including the flight paths for getting in and out of the area, dates back decades, when traffic was much lighter. The FAA has been trying for years to "redesign" it, in its plans, to allow more planes to get in and out. But according to the FAA's plan to increase airspace capacity, especially in the Northeast, and to get away from the status quo and act boldly to modernize our nation's outdated air traffic control system.

"Delta's focus is always the very best, but not all the delays that continue to work to mitigate delays. However, today's statement Congress act to modernize the traffic control system, Nor-Mark, Delta's executive, who is fundamentally unfair to our customers that are operating in an outdated system that was built in the 1940s and can't accommodate today's air travel demand without costly and frustrating delays and congestion that are beyond our control. The FAA has presented a plan to Congress that helps ensure air travelers are provided with an updated, 21st century air traffic control system. We urge Congress to approve the FAA's plan to increase airspace capacity.

For the inside story on the big-time Washington battle over restructuring the FAA, see associate editor Angie C. Marek's March 20, 2007, article, here. Marek tells us that bills addressing the subject should appear in Congress soon.

In response to an Airline Quality Rating report released yesterday that found that instances of delayed flights and lost luggage were up last year over 2005, the Air Transport Association, the trade group representing the major airlines, released a statement yesterday.

In short, the airlines attribute the uptick in delays to one of the most contentious political issues in transportation: this year's updating of the air traffic control system and just who should pay the bill for the much-needed improvements.

"The 2007 Airline Quality Rating study once again focuses on the symptoms rather than the root causes of passenger and airline frustrations," ATA President and CEO Jim May notes in the statement. He says that since the majority of delays are caused by weather problems that the current system can't handle, Congress must now take its "historic opportunity" to "approve an action plan for the Next Generation Air Traffic Control system... while ending the multi-billion-dollar subsidy of business jets at the expense of the commercial airline passengers."

"Delta's focus is always the very best, but not all the delays that continue to work to mitigate delays. However, today's statement Congress act to modernize the traffic control system, Nor-Mark, Delta's executive, who is fundamentally unfair to our customers that are operating in an outdated system that was built in the 1940s and can't accommodate today's air travel demand without costly and frustrating delays and congestion that are beyond our control. The FAA has presented a plan to Congress that helps ensure air travelers are provided with an updated, 21st century air traffic control system. We urge Congress to approve the FAA's plan to increase airspace capacity.

For the inside story on the big-time Washington battle over restructuring the FAA, see associate editor Angie C. Marek's March 20, 2007, article, here. Marek tells us that bills addressing the subject should appear in Congress soon.
Pressure of Global Warming Concerns on Flight Efficiency and Fuel Consumption

Needless delays add to pollution
by David Learmount

Eurocontrol demands more efficiency from air traffic management and fewer carbon emissions.

Aircraft flying in European airspace last year poured thousands of tons of carbon dioxide into the sky unnecessarily just because of management inefficiency, according to the Eurocontrol Performance Commission (RPC).

The report on calendar year 2006, published on 11 May, shows that delays have been increasing for three years in a row, and RPC Chair Wynne Williams says that the need to improve ATM efficiency is rising as a result.

The excess of emissions results from inefficiencies in the continent which mean every flight travels nearly 50 km (27 miles) farther than it needs to in order to reach its destination, the RPC reports. But RPC has set a target of eliminating the problem by 2010, saving an estimated 2.3 million tonnes of CO2 emissions and thereby reducing airline costs by a billion euros.

Carbon dioxide represents about 80% of the man-made greenhouse gases blamed for global warming. Though experts have called for the United States and other nations to cut emissions of CO2, current trends allow atmospheric CO2 concentration to double by the end of the century.

Concern grows over pollution from jets
by Gary Stoller, USA TODAY

A Boeing 737 lands in DC, net emissions such as carbon dioxide, nitrogen oxide and water vapor can contribute to climate change.

Carbon dioxide represents about 80% of the man-made greenhouse gases blamed for global warming. Though experts have called for the United States and other nations to cut emissions of CO2, current trends allow atmospheric CO2 concentration to double by the end of the century.

A House committee chairman wants the FAA to include global warming in its Next Generation Air Transportation System (NextGen) planning.

Rep. Edward Markey (D-Mass.) wrote FAA Administrator Marion Blakey Aug. 14 to express concerns that the agency wasn't taking global warming into account as it planned the future or air traffic control. "American aviation has made the world a smaller place and now it can make it a healthier place by taking action on global warming," said Markey, chairman of the House Select Committee on Energy Independence and Global Warming.

The letter asks FAA to report back by Sept. 4 on four questions: What does NextGen consider aviation's current and anticipated impact on global warming? How many tons of carbon dioxide does aviation emit on a yearly basis in the U.S.? - both in the air and on the ground? What strategies is NextGen considering to address emissions at airports? and how far along is NextGen in developing a national roadmap on the viability of alternative fuels for aircraft?
Why NextGen?

- Growth in volume and complexity of operations
- Scalable to encompass a range of possible futures
- Broader diversity of:
  - Aircraft performance characteristics
  - Aircraft capabilities
  - Operator business models
- Space Operations
- Unmanned Aerial Systems

Transformation is Needed to Accommodate Projected Traffic Levels and Characteristics
What is NextGen?

Transformation goals:
- Leadership in global aviation
- Scalable up to 3x increase in capacity
- Ensure our national defense (readiness and homeland security)
- Enhance the environment (noise, air quality)
- Improve safety
- Globally harmonized

Capabilities:
- Network-Enabled Information Access
- Performance Based Operations & Services
- Weather Assimilated into Decision Making
- Layered, Adaptive Security
- Position, Navigation, and Timing Services
- Aircraft Trajectory Based Operations
- Equivalent Visual Operations
- Super Density Arrival/Departure Operations
NextGen Enterprise System Engineering Challenges

Enterprise System Engineering Profiler™
NextGen Challenges: Strategic and System Contexts

- **System Context**
  - **System Behavior**
    - NextGen must be flexible to meet a range of air transportation system futures
  - **Desired Outcome**
    - Transformed air transportation system that leverages new technologies and requires policy and roles and responsibility changes

- **Strategic Context**
  - **Scope of Effort**
    - Interdependencies of all elements contributing to air transportation
  - **Mission Environment**
    - Mission evolving to accommodate new types of operations
NextGen Challenges: Stakeholder and Implementation Contexts

• Stakeholder Context
  – Stakeholder relationship
    • Large and diverse stakeholder community
  – Stakeholder Involvement
    • Diversity of stakeholders leads to conflicting objectives; e.g.,
      – NextGen funding mechanisms
      – Aircraft equipage mandates
      – Airspace access

• Implementation Context
  – Acquisition Environment
    • Synchronization of research, development, and implementation of multiple government agencies and the private sector
  – Scale of Effort
    • Flexibility required to accommodate multiple user operating models
Process for Achieving NextGen

Baseline and Assess Today's Performance, Service, and Cost of Segment
- Define the “What”
- Architect & Analyze
- Define Solutions
- Execute & Measure

Define Concept of Operations; Identify Operational Improvements

Develop Enterprise Architecture; Analyze Alternative Solutions and Assess Tradeoffs

Measure Post-Implementation Performance

Define and Implement Incremental Solutions
- Policy, Portfolio, Roadmaps, and Business Cases

Determine Program and Research Needs
Baseline and Assess Today’s Performance

- Understand Federal agency and private sector plans, including architectures
- Baseline current capabilities and performance
Concept of Operations

- Describes national airspace system (NAS) in 2025
  - Highlights differences from today’s operations
- Presents an “aggressive” set of concepts
  - Maximize benefits and flexibility to users
- Identifies key research issues needing resolution
- Highlights areas for policy decisions
- Many possible futures
  - Down-selection and refinement of concepts to occur through research and policy decisions
Operational Improvements

- **Definition** – A change in operations that produces a beneficial result and moves the air transportation system toward the 2025 NextGen Goals and Objectives
- ~130 OIs are grouped to describe the *operational* transition path toward the future
- OI roadmaps span the strategies and key capabilities described in the Integrated Plan
Enterprise Architecture

- Federal Enterprise Architecture Framework (FEAF) and extensions for air transportation
- Department of Defense Architecture Framework (DODAF) – selected and tailored operational, system, and technology views
- Federal Transition Framework (FTF) – Air Transportation Line of Business proposal

- Tool to relate and integrate NextGen Federal agency and private sector efforts
  - Planning, portfolio management, and system acquisition
  - Key purpose: support OMB investment decision process
- Models to describe the NAS from operational, information, systems, technology, and performance perspectives
Determine Program and Research Needs

- JPDO working with government agencies and private sector to determine program and research needs
  - Considers agency specific strategic plans
- CONOPS has top-level research issues
- FY09 to FY13 Research and Development Plan developed to support budget formulation
- Demonstrations identified to assess operational concepts, system implementations, or technologies
Define and Implement Incremental Solutions

- Full range of DOTMLPF solutions applies across public and private sectors
- Policy issues addressed in an integrated manner
  - Examples: surveillance integration, navigation system backup, and equipage for required performance
- Portfolio management
  - Investments selection (program and research)
  - Collaborative effort among stakeholders, including the agencies, and OMB
  - Business case includes benefits and costs
  - “Portfolio” view is needed to justify investments contributing to OIs – not a program by program view
- NextGen Integrated Work Plan
  - Time phased plan consolidating OI roadmaps, research plans, policy needs, and other implementation supporting material
- Agencies and private sector implement; JPDO monitors and assess progress, including performance and cost
Government leadership reflects participation from NextGen agencies.
Organization tailored to achieve enterprise transformation.
JPDO includes government, contractor, and Federally Funded Research and Development Center (FFRDC) managers and staff.
Working Groups responsible for domain-specific products
  – Include government, NextGen Institute, and FFRDC members.
Multilevel governance includes cabinet level leadership (SPC).
## NextGen Stakeholder Participation

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Roles and Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agencies</td>
<td>Develop and review overarching products, conduct government research, and implement government programs</td>
</tr>
<tr>
<td>Private sector</td>
<td>Develop and review overarching products, conduct private sector research, and implement private sector programs</td>
</tr>
<tr>
<td>Office of Management and Budget</td>
<td>Review NextGen EA and review of NextGen Business Case</td>
</tr>
<tr>
<td>Congress and Government Accountability Office</td>
<td>Conduct review of NextGen progress reports and selected products, and review of JPDO effectiveness</td>
</tr>
<tr>
<td>Department Inspectors General</td>
<td>Conduct review of JPDO effectiveness</td>
</tr>
</tbody>
</table>
Lessons Learned

• Governance must be established early to ensure the roles and responsibilities of participating government organizations and industry stakeholders are clearly defined and described
  – Boundaries and activities which delineate the “who does what”
  – Scope and depth of the interoperability required between multiple agencies’ and industry, various activities and systems/applications
  – Information exchange required among participants

• JPDO could not reuse existing single agency processes and products without changes to plan and oversee implementation of NextGen
  – Single agency coordination processes and products were not sufficient to address mission needs, although most came from the participating agencies themselves
  – Need to consider public-private partnership, multi-agency operations, cross agency investments, and long term planning horizon influence
Lessons Learned

• Multi-agency organizations require a common way to describe key aspects of cross agency planning
  – Common products and process flow
  – Level of detail varies by area – overlap with agency products expected
  – Concerns differs across stakeholders – White House, Congress, industry groups, etc.
  – Visibility into evolving products needed while protecting sensitive information

• JPDO continues to deal with complexity that increases with scope, diversity of stakeholders, time horizon, applicable technologies, policy areas, etc. – more complex than single agency effort
  – Processes continue to evolve to achieve the products that are understandable by the various agencies and industry
  – Long time horizon means that “design space” will not close until R&D complete

• Public-private partnerships require government and industry leadership and staffing
  – Work groups have government and private sector co-leads and participation
  – Industry representatives are members of the Integration Council
Summary

• NextGen is a pathfinder for addressing large scale, multi-agency enterprise system engineering challenges
  – Joint and sometimes conflicting missions
  – Transformation of services
  – Reducing costs for government, industry and the public

• Multi-agency and public-private efforts involve higher complexity and additional products and processes compared to single agency programs

• Progress depends on satisfying multiple stakeholders while maintaining focus on most important products and impacts
For More Information

• Joint Planning and Development Office:
• NGATS Institute: