En Route Data Communications:
Joint Analysis Team Assessment

NAC Task 23-3 Report

To be presented to the NextGen Advisory Committee

December 10, 2024

Executive Summary

In December 2023, the Federal Aviation Administration (FAA) tasked the NextGen Advisory Committee (NAC) with providing consensus measurement of operational benefits of En Route Data Communications. The NAC Joint Analysis Team (JAT) received this tasking and deliberated for approximately ten months, reviewing data and modeling to address the elements of the tasking.

The JAT has noted that En Route Data Comm is at an early stage of implementation (initial services not implemented in every Air Route Traffic Control Center (ARTCC) yet and full services planned for 2027). Understanding that the program is at a relatively early stage of implementation, the JAT explored efficiency improvements as the primary benefits mechanism in this assessment. A large-data regression model was used to assess distance/time savings for aircraft rerouted using En Route Data Comm. This methodology was also informed by a qualitative airline survey and detailed specific scenario review. The findings include a positive benefits signal (0.8-1.4 nmi savings for En Route Data Comm rerouted flights). En Route Data Comm is valuable, but there are still technical issues (that are seen with programs at this stage of implementation) that hinder usage and potential benefit. The benefit signal above is from historical data and includes constraints currently limiting benefits.

The JAT also has the following recommendations for additional future analyses:

- After a sufficient burn-in period to allow steady-state operations, revisit benefits/impacts analysis after all ARTCCs have initial services and also after full services;
- Explore other benefits mechanisms and other benefits methodologies, collaboratively with relevant operational stakeholders.

Contents

Background

During the October 4, 2023 NextGen Advisory Committee (NAC) meeting, after the Federal Aviation Administration (FAA) Air Traffic Organization (ATO) En Route Data Communications Program team communicated the implementation progress and the NextGen Integration Work Group (NIWG) leads described equipage levels, several NAC members shared their perspectives on En Route Data Comm. The NAC discussion highlighted the value of the emerging capability, especially as the implementation traversed the continental US. It was noted during the NAC discussion, that the availability of consensus, quantified impacts of En Route Data Comm could aid operators with their equipage decisions. The NAC Subcommittee (NAC SC) Chairperson requested the FAA consider a tasking to determine the benefits of En Route Data Comm and the action was noted in the official meeting minutes.[1]

The FAA also acknowledged the value of an early En Route Data Comm analysis and in December 2023, the FAA Deputy Administrator Katie Thomson tasked the NAC (see Appendix A for copy of the tasking letter). The FAA requested that the NAC develop industry consensus on the following elements:

- Identifying benefit mechanisms of En Route Data Comm;
- Identifying data source(s) and data validation steps;
- Describing the benefit methodologies of En Route Data Comm; and,
- Quantifying operational benefits of En Route Data Comm.

The FAA's letter identified that the task scope cover all en route Air Route Traffic Control Centers (ARTCCs) with operational En Route Data Comm and stated that the results be presented by the fall 2024 NAC meeting. The request also identified the Joint Analysis Team (JAT) under the NAC SC as the appropriate element within the NAC structure to work the tasking.

This report documents the efforts of the JAT to address the December 2023 tasking and presents the group's findings and recommendations.

Methodology Overview

To address the tasking elements, the JAT conducted a series of meetings between January and October 2024. These meetings are summarized below:

- The full JAT met four times to review proposed analysis methodologies and preliminary results.
- Operator members of the JAT met separately on three occasions to review and discuss perspectives to ensure common views were brought to the full JAT meetings.
- JAT leadership met monthly to ensure that the group deliberations stayed on schedule and that all aspects of the tasking scope were addressed.

---

[1] NextGen Advisory Committee October 4, 2023 Meeting Summary, located on the FAA's NAC website, https://www.faa.gov/sites/faa.gov/files/October_4_NAC_Meeting_Summary.pdf

Given the technical nature of the En Route Data Comm program, the NAC SC asked that the JAT augment its standing membership with the appropriate industry subject matter experts (SMEs) that were familiar with the operational nuances of program. The FAA provided SMEs from the NextGen Systems Engineering and Integration Office (ANG), the ATO Program Management Office (AJM) and ATO Operations Office (AJT). The FAA also provided access to analysts, data and tools from the MITRE Corporation (MITRE) and the contractors supporting the En Route Data Comm program.

Benefits Mechanisms

The JAT was supplied with background information from the AJM En Route Data Comm team. In general, En Route Data Comm supports "the transmission of complex instructions that can be quickly and efficiently loaded into an aircraft's flight management system upon review and acceptance by the pilots."[2] The FAA has identified four primary benefits mechanisms (depicted in Figure 1). The JAT concurred with this characterization of the potential benefits areas for En Route Data Comm.

Figure 1: En Route Data Comm Benefits Mechanisms

The scope of the benefit for JAT consideration is defined by the operational improvements supported by Initial Services of En Route Data Comm at the Air Route Traffic Control Centers (ARTCCs) where those services have been implemented. Initial Services is the first increment of En Route Data Comm capabilities and include Transfer of Communications, Reroutes, Altitudes/Altimeters, Speeds, and Pilot downlinks. As of November 2024, ARTCCs with initial services included all CONUS centers with the exception of Albuquerque (ZAB), Memphis (ZME), Boston (ZBW) and New York (ZNY).

[2] FAA Website: https://www.faa.gov/air_traffic/technology/DataComm

Using the experience from previous analysis of tower data comm Departure Clearance (DCL)[3], the JAT analysis focused on the efficiency of communicating reroute clearance. En Route Data Comm route uplink messages can support quicker movement to a reroute thus saving some flying distance. Referring to Figure 2, the benefit is the difference between the longer path flown with voice re-route (orange line) and shorter path flown with data comm re-route (green line)[4]. While this is the primary expected driver of the JAT analysis, there are other possible drivers of an En Route Data Comm distance savings including controller use of "trackball reroutes" or any instances where a reroute was issued with En Route Data Comm that would have not been issued with voice due to complexity or controller workload.

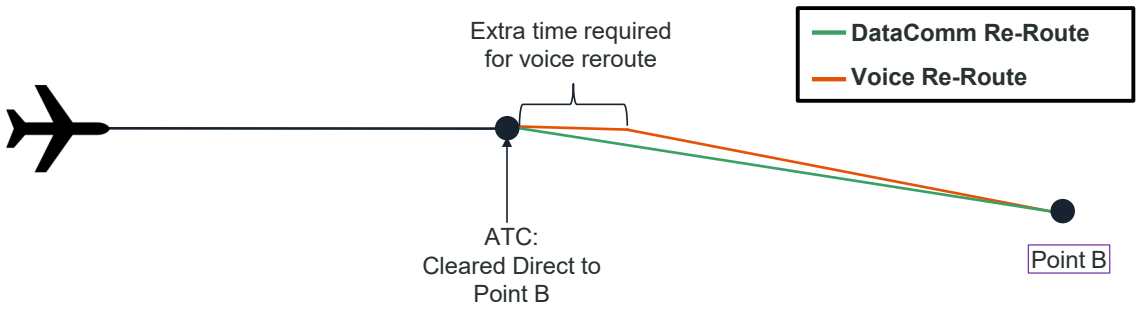


Figure 2: Reroute Communication Efficiency Enabled by En Route Data Comm

The JAT discussed other efficiency-related benefits (e.g., faster clearances to higher altitudes during climb), but felt it was not feasible to explore those in the tasking time frame. Future analyses are discussed in the "Findings and Considerations" and "Recommendations" sections of this report (with additional details in the report appendices).

Data Sources

In exploring the benefits associated with the efficiency of communicating reroutes, the JAT identified two primary pieces of data that would be needed for its assessment:

- Flights that received a reroute with En Route Data Comm. This can be achieved by distinguishing flights that received reroutes verbally from those with uplinked messages[5].

---

[3] "Joint Analysis Team: Performance Assessment of Boston/Gary Optimal Profile Descents and DataComm," RTCA, October 2017.

[4] Note that this does not imply any efficiency associated with the specific reroute (time or distance), only the efficiency of communicating the reroute.

[5] Reroute uplink messages include UM74 - proceed direct to (position), UM79 - cleared to (position) via (route clearance), or UM80 - cleared (route clearance). All Initial Services message types are defined in Aeronautical Information Manual (AIM), Section 4.2 En Route Communications, para 4.2.1.3, Table GEN 3.3-1 through GEN 3.3-19.

The uplink data was provided by L3Harris, a contractor for the FAA's Data Comm program, and it is not readily available outside of the FAA.

- Distance flown, accounting for departure location, arrival location, and geographical distance of the departure and arrival locations. There are several sources for this data, both publicly available and some proprietary to the FAA.

Benefits Methodologies

As the JAT began its deliberations, it wanted to understand previous and on-going analyses related to En Route Data Comm. The FAA Program Office and the Data Comm NIWG have been sharing metrics about the program for several years[6].

At the initial meeting to this tasking, the FAA asked its contractor L3Harris to present the methodology that had been developed to estimate time/distance efficiency benefits[7]. The L3Harris method assumes that individual flight comparison (i.e., equipped vs. non-equipped) would be unduly cumbersome given the myriad of variables. It uses a large-data regression model to develop a benefit coefficient, which then could be applied across all effected flights.

While the JAT did not disagree with the L3Harris large-data approach, there were several questions:

- Given existing operational and technical growing pains, did this data modeling reflect the perspectives of front-line operational stakeholders such as pilots and controllers?
- How does this large-data approach compare to actual scenarios of use, in particular in the delivery of reroutes in congested airspace?
- How relatable is the resulting benefits coefficient to NAC-level decision makers? Much of the analysis included data that is not available outside the FAA, thus could not be compared to or validated with operator sources.

To address the concerns around flight crew operational feedback, A4A offered to poll its Operations Council[8]. Understanding that subjective surveys are not traditionally something the JAT has used, the team decided that it was important to obtain this perspective and to apply the

---

[6] The En Route Data Comm Program Office regularly computes and shares statistics in multiple forums. From May 2019 through June 2024, the program has mitigated almost 1.6M read-back errors and saved almost 6M minutes of pilot/controller communications time.

[7] Time/distance metrics have been the focus of several previous JAT analyses and can be readily be translated into fuel, CO_2 and value estimates.

[8] Airlines for America (A4A) is an airline advocacy organization working to shape crucial policies and measures that promote safety, security and a healthy U.S. airline industry. The Operations Council is one of A4A's working elements, https://www.airlines.org/

responses to the tasking deliberations. This survey was conducted in August-September 2024 and results are detailed in Appendix F and summarized as:

- A4A airlines expressed value of En Route Data Comm when it functions as intended, and support continued problem resolution and implementation. Airlines have made significant investments in crew training, technology, software and operations.
- Key value included the ability to receive loadable clearances which directly mitigates the risk of read-back errors and enhances efficiency. Some survey responses shared high benefit on a "per flight" experience. Identified weaknesses included that the capability can be time consuming.
- The overall impression from the responses was cautiously positive – there is benefit but is hampered by existing operational and technical challenges, and lack of implementation in all CONUS ARTCCs.

The JAT agreed that there was value in conducting a scenario-based review of Data Comm operational impact to better illustrate benefits based on actual use cases. This detailed analysis of a few specific examples was conducted to confirm the large-data results and also tie back to the original benefits questions voiced at the October 2023 NAC meeting. The FAA tasked MITRE, with support from L3Harris, conducted a detailed comparison of verbal vs. uplinked route clearances. This was done in sectors with a high-number of route uplinks. The MITRE analysis looked at scenarios in Jacksonville ARTCC (ZJX), Miami ARTCC (ZMA), and Houston ARTCC (ZHU), and details can be found in Appendix E. The scenarios clearly identified the communications workload, and the value of En Route Data Comm in managing communications to effectively transmit reroutes (in weather and volume situations).

Building on both the A4A Ops Council survey and the scenario-based analyses, the NextGen Systems Analysis and Modeling group updated the large-data regression model approach (described in Appendix D) using data from January 2023 through June 2024. This updated approach is the primary methodology that JAT settled on to address the tasking questions. Two key enhancements with this update included: 1) refinement of flights to city pairs where En Route Data Comm has been used to communicate the reroute, and 2) the inclusion of PDARS data to analyze flight distance including removal of trajectories inside a 40nmi circle around airports. Both of these enhancements improve the fidelity and understandability of the resulting benefits estimates (see Appendix D for additional details).

Findings and Considerations

Based on the enhanced large-data approach, qualitative survey and scenario review, the following points summarize the findings of the JAT for this tasking:

- En Route Data Comm is valuable, and several operators have equipped large parts of their fleets. There are safety and efficiency benefits related to managing communications workload (as illustrated in the detailed scenarios).
- Technical issues (that often are seen with programs at this level of implementation) can hinder usage and potential benefit. The ability to address these issues should be monitored and be taken into account is evaluating program maturity.

- The large data approach (considering only reroutes) did provide a quantitative time/distance benefit, 0.8-1.4 nmi savings for En Route Data Comm rerouted flights. Using a mid-range value of 1.1 nmi per flight, this translates to a time savings of approximately 10 seconds per flight.
- Shorter flights (e.g. city-pair great circle distance <1,200 nmi) generally showed larger benefit than longer flights. This is likely due to great circle being less of an optimal path on longer flights as airlines look to take advantage of jet stream and wind optimality.
- Generalized time/distance savings (from the large-data approach) are not insignificant when annualized and accumulated over several years: $10M (assuming $3,500/hour airborne airline direct operating costs (ADOC)) to $32M (assuming $8,000/hour passenger value of time (PVT)) annual savings.[9]
- These benefits are scoped by the available initial services; full services[10] are expected to enable operational enhancements (e.g., UPTs) that could provide greater benefits.
- En Route Data Comm quantified benefits are expected to grow. As more ARTCCs come on line (with initial and full services) and more aircraft are equipped, operational familiarity for pilots and controllers will increase and contribute to additional benefits.
- Additional analyses and/or modeling applications may be needed to capture benefits mechanisms not addressed with the large-data approach (identified in Appendix D).

While not an explicit finding of the JAT, it was recognized by the operator members that each is balancing investment decisions across their fleets and it is their option to use these results for future planning. Operators are encouraged to continue to apply MCL recommendations for forward-fit equipage decisions.

Recommendations

In additional to the JAT findings above, the team offers the following recommendations for future work to understand and report the benefits of En Route Data Comm.

- Continue to collect and review data supporting updated benefits/impacts analysis after all ARTCCs have initial services, and again after all ARTCCs have full services[11]. The updated analysis should occur after a sufficient burn-in period to allow steady-state operational integration of the capabilities.
- Investigate other benefits mechanisms not included in this analysis, to include but not limited to: Voice re-routed aircraft will also get a re-route faster; Uplinked Transfer-of-Communications free frequency for other tasks (including earlier delivery of re-routes); Faster clearances to higher altitudes during climb; Exiting holds faster; Fewer Traffic Management Initiatives (e.g. Miles-in-trail, AFPs).

---

[9] Standard FAA valuation assumptions.

[10] En Route Full Services include the previously baselined capabilities: Controller Initiated Re-routes (Full Capability), Direct-to-Fix Messages (Full Capability), and Crossing Restrictions (Full Capability), Advisory Messages, and Holding Instructions.

[11] Note that at the time of this report, the FAA projected completion for Initial Services is Q2 CY2025 and the projected completion for Full Services is Q4 CY2027.

- Explore benefits methodologies that leverage modeling applications. Modeling, based on historical data, operational inputs, and contextual assumptions (provided by subject matter experts), can mitigate challenges caused by a myriad of dynamic operational variables (e.g., weather and demand) that can complicate post-implementation measurements.

This JAT tasking has shown that a mixture of operational and analytical expertise is needed to adequately conduct this type of benefits assessment, and future work should be executed collaboratively with relevant operational stakeholders.

Appendix A: FAA Tasking Letter

U.S. Department
of Transportation
**Federal Aviation
Administration**

Office of the Deputy Administrator

800 Independence Ave., S.W.
Washington, DC 20591

December 21, 2023

Mr. Russell "Chip" Childs
President and Chief Executive Officer SkyWest, Inc.
444 South River Road
St. George, UT 84790

Dear Mr. Childs:

The Federal Aviation Administration (FAA) requests consensus advice from the NextGen Advisory Committee (NAC) to help measure the benefits of En Route Data Communications (Data Comm). The FAA requests the NAC to develop industry consensus on the benefit mechanisms, benefit methodologies, and quantified performance impacts from the implementation of En Route Data Comm.

Task 23-3: En Route Data Communications: Joint Analysis Team Assessment

The NAC is asked to work with the Data Comm NextGen Integration Working Group to form a Joint Analysis Team (JAT) to reach an industry consensus on the operational benefits resulting from the implementation of En Route Data Comm.

The NAC advice should include the following:

- Identified benefit mechanisms of En Route Data Comm
- Identified data source(s) and data validation steps
- Description of the benefit methodologies of En Route Data Comm
- Quantified operational benefits of En Route Data Comm

The program scope for this tasking shall include the following:

- All Air Route Traffic Control Centers with active En Route Data Comm
- All relevant data source(s)

The FAA requests the JAT to provide an update at each of the NAC meetings through calendar year 2024, with the final report by the Fall 2024 meeting.

If you have questions, please contact Kimberly Noonan, NextGen Stakeholder Collaboration Manager, at Kimberly.Noonan@faa.gov.

Sincerely,

Kathryn B. Thomson
Deputy Administrator

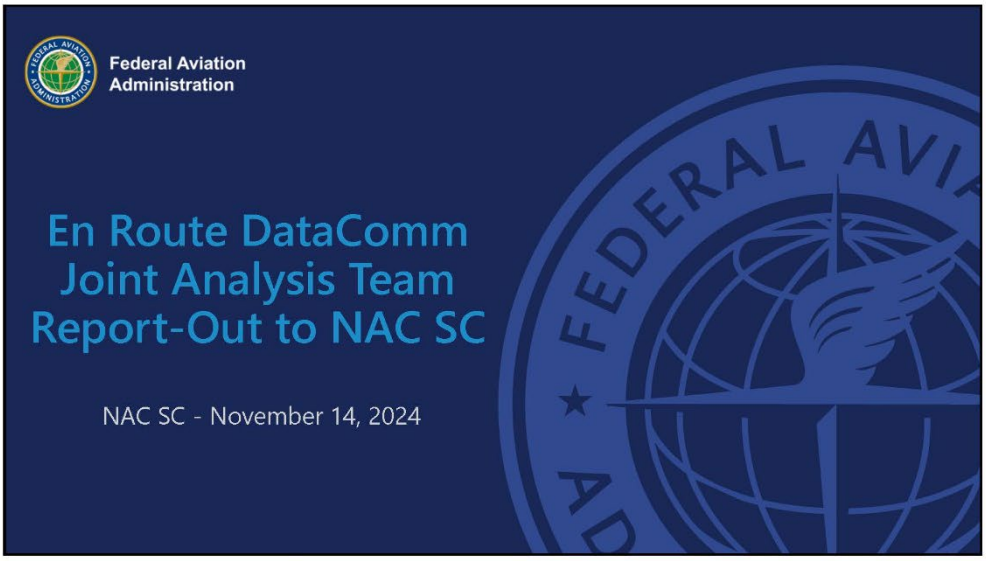
Appendix B: Contributors from Joint Analysis Team and Industry En Route Data Communications Experts

Air Line Pilots Association (ALPA)
Airlines for America (A4A)
Airports Council International - North America (ACI-NA)
Alaska Airlines
Allied Pilots Association (APA)
American Airlines
Delta Air Lines
FedEx Express
Federal Aviation Administration NextGen Systems Engineering and Integration Office (ANG)
Federal Aviation Administration Air Traffic Organization Program Management Office (AJM)
Federal Aviation Administration Air Traffic Organization Operations Office (AJT)
JetBlue Airways
L3Harris Technologies
The MITRE Corporation
National Air Traffic Controllers Association (NATCA)
National Business Aviation Association (NBAA)
Port Authority of New York and New Jersey (PANYNJ)
SkyWest Airlines
Southwest Airlines
United Airlines
United Parcel Service

Appendix C: Acronyms

ADOC	Airline Direct Operating Cost
ARTCC	Air Route Traffic Control Center
ATO	Air Traffic Organization
CONUS	Contiguous United States
CPDLC	Controller Pilot Data Link Communications
Data Comm	Data Communications
DCL	Departure Clearance
FAA	Federal Aviation Administration
JAT	Joint Analysis Team
MCL	Minimum Capabilities List
MIT	Miles in Trail
NAC	NextGen Advisory Committee
NAC SC	NextGen Advisory Committee Subcommittee
NAS	National Airspace System
NextGen	Next Generation Air Transportation System
NIWG	NextGen Integration Work Group
nmi	nautical mile
PDARS	Performance Data Analysis and Reporting System
PVT	Passenger Value of Time
SME	Subject Matter Expert
UPT	User Preferred Trajectory

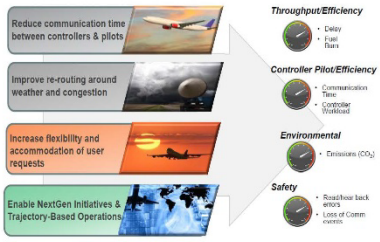
Appendix D: Enhanced Large-Data Approach Details



Bottom Line Up Front

- FAA and L3Harris have agreed on a “Big Data" methodology to produce a quantified estimate of DataComm benefits
  - Now includes data from 2023 and first half of 2024
- "Big Data" method uses regression model to compare flights that were:
  - Rerouted with DataComm messages
  - Rerouted via voice
- Based on this analysis of historical data, we see an initial quantifiable signal of DataComm benefits associated with rerouted aircraft
- Data should continue to be collected and evaluated
  - Benefits are expected to grow

We all believe in en route Data Comm benefits



- **Agree with the underlying benefit tenets**
- **<u>But</u> quantifying the benefits is complex (qualitative easier than quantitative)**

- **Similar but different from tower data comm**
- **Still early in the Data Comm program**
  - **Ongoing issues continue to be worked between FAA/industry**
  - **En Route Full Services beginning deployment**
  - **Additional complexity on measurement**

Why "Big Data" Regression Model Analysis approach?

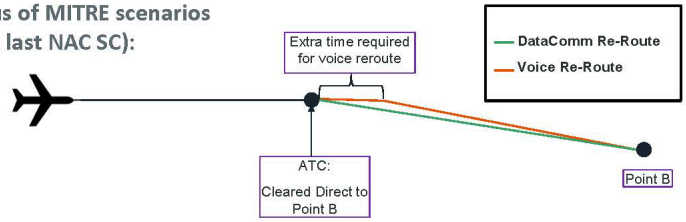
Comparing Voice vs CPDLC flights that received a revision is done with a large data modeling approach. There are too many variables to look at data flight by flight.

The data will be reviewed as a collective data set.

- A regression model was used to assess the value of using CPDLC on distance flown accounting for:
  - Departure Location
  - Arrival Location
  - Origin-Destination Great Circle Distance
- The model was applied to all flights that received a voice vs data comm reroute

Notional "Big Data" benefit mechanism

Primary expected driver (and focus of MITRE scenarios shown at last NAC SC):



Other possible drivers:

- Trackball reroutes that allow controllers to pin an aircraft on a precise route around weather or restricted airspace
- In some cases, an aircraft may get a reroute or shortcut via DataComm that they would not get via voice due to complexity and workload

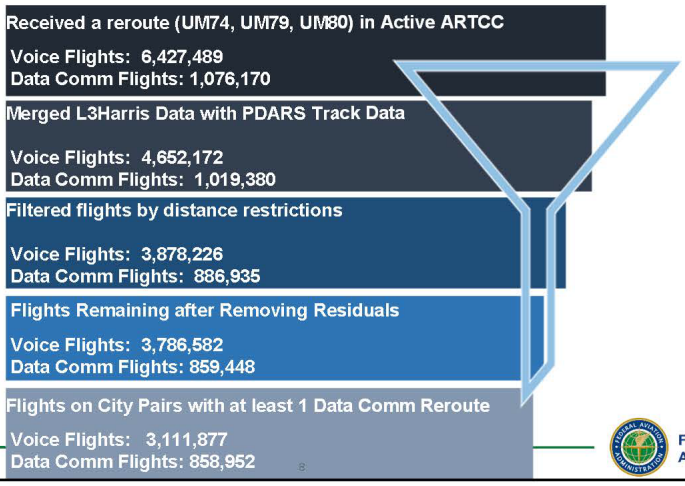
Other potential benefits not captured by "Big Data"

- Voice rerouted aircraft will also get a reroute faster
- Uplinked Transfer-of-Communications free frequency for other tasks (including earlier delivery of reroutes)
- Faster clearances to higher altitudes during climb
- Exiting holds faster
- Fewer Traffic Management Initiatives (e.g. Miles-in-trail, AFPs)
- Safety

Federal Aviation Administration

Data Comm Benefits: Focus on Re-Routes

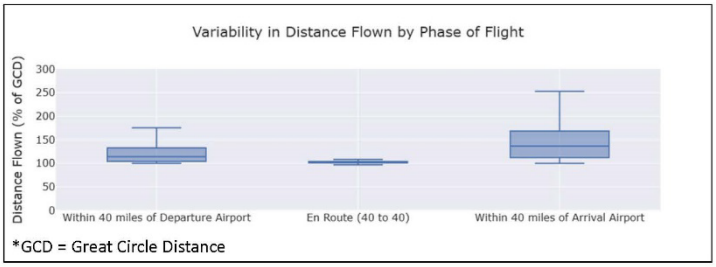
January 2023-June 2024



Federal Aviation Administration

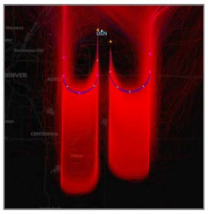
Terminal Area Effects in "Big Data" analysis

- Original analysis included full flight track (origin to destination)
- In general, there is large variation in distance flown during departure and arrival phases of flight
- Specific causes can include airport configuration, departure and arrival procedures, and arrival sequencing delay
- These causes, particularly on arrival side, are generally unrelated to flight re-routing and DataComm usage
- Updated method excludes last 40 miles of track



*GCD = Great Circle Distance

DEN Downwind Variation



Federal Aviation Administration

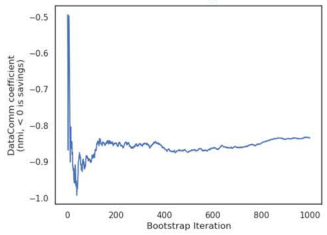
Establishing an Initial Benefits Range

- Until recently, analysis has been focused on 2023 data
  - Recent analysis by month showed reduced signal (i.e. DataComm coefficient) in second half of 2023
- New 2024 data received October 30, 2024
  - 2024 data continues to show a reduced signal
  - Beginning work to understand this reduced signal
- Proposing an initial quantified benefit range:
  - Lower bound: Results from 2024 data only
  - Upper bound: Results from full 18 months of available data (January 2023 – June 2024)
- This range is meant to be representative of **current quantifiable benefits**

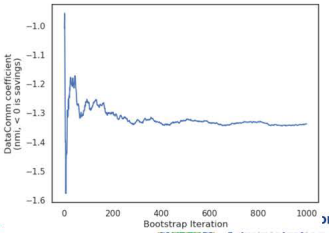
Federal Aviation Administration

DataComm Benefits: Origin to 40 miles from Arrival Airport

- Low estimate (Early Look)
  - Based on January 2024 through June 2024:
  - Results: Flights receiving DataComm reroute had savings of 0.8 nmi per flight



- High estimate (Early Look)
  - Based on January 2023 through June 2024:
  - Results: Flights receiving DataComm reroute had savings of 1.4 nmi per flight



Federal Aviation Administration

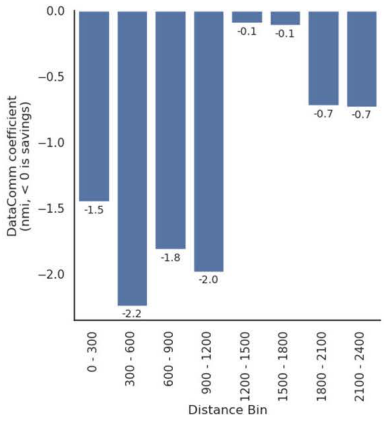
Why might signal be decreasing?

1. Voice aircraft benefiting from increased DataComm usage?
2. Learning curve associated with new center usage?
3. Change in city pair mix driving signal as DataComm expands (i.e. more longer flights)?
4. Other confounding factors beyond DataComm influencing signal?

Federal Aviation Administration

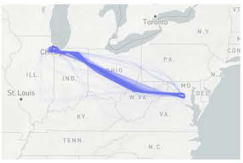
DataComm Benefits: Origin to 40 miles from Arrival

Binned by City Pair Great Circle Distance



Distance flown to Arrival 40

DCA-MDW:
Mean 501 nmi, St.Dev 22



Greater track dispersion for farther city pairs, GCD is not the optimal path and therefore measure may be less appropriate

LAX-JFK: Mean 2196 nmi, St.Dev 62

NAC SC - November 14, 2024

Summary and Future Consideration

- Based on early "Big Data" findings, a quantified per-flight benefit range of 0.8-1.4 nmi for DataComm rerouted flights is proposed
- Example savings for approximately 1M DataComm rerouted flights annually:
  - Assumes 10 seconds per flight (1.1 miles)
  - Assumes $3500 per hour (Airborne ADOC) and $8000 per hour (PVT)
  - $10M (no PVT) to $32M annual savings from early quantified look
- DataComm quantified benefits will grow
  - More centers and aircraft using DataComm over time
  - Increased controller and pilot familiarity
  - Monitor how DataComm issues highlighted in A4A survey are resolved
  - Larger signal may come outside of "Big Data" methodology

NAC SC - November 14, 2024 14

Federal Aviation Administration

Backup

Federal Aviation Administration

En Route CPDLC by the Numbers

March 2019 – June 2024

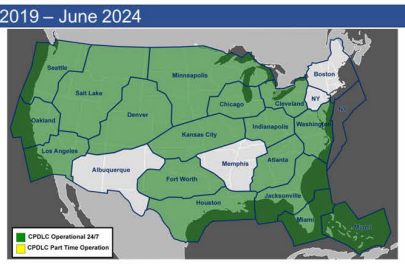
61,483,519 transactions

8,088,226 sessions

27 commercial aircraft types

56 commercial operators

Over 6,700 equipped aircraft



1,572,167 readback errors mitigated

5,938,521 minutes of comm time saved

Appendix E: Scenario Review Details

Content

- Purpose: Provide examples of Data Comm's operational impact on airspace users
- Operational Benefits of Data Communications
- Processes for Identifying and Analyzing Operational Impact
- Challenges to Conduct Analyses
- Sectors with Many Route Uplinks
- Scenarios with Operational Impact

Operational Benefits of Data Communications

- Based on past benefit analyses and feedback from controllers and pilots, areas of operational benefit include
  - Uplink of routes
    - Push-to-Load of uplinked routes into Flight Management System eliminates misunderstanding and "typos"
    - Reduces frequency use for clearances and readbacks; particularly when fixes need to be spelled phonetically
  - Eliminates Readback/Hearback errors for uplinked clearances or sector frequencies
  - Reduces routine communications such as transfer of communications

Federal Aviation Administration

Process for Identifying and Analyzing Scenarios (1/3)

- L3Harris identifies potential interesting events (date, time, sector)
  - Complex ATC events such as weather along with clusters of route uplinks
- MITRE analyzes these events in detail
  - Pulls all Data Comm messages from SkyDataSentry
    - Data pull is limited to less than a day at a time
    - Controller-Pilot Data Link Communication (CPDLC) messages based on tailnumber (not callsign)
  - Uses dynamic map tools to illustrate the merged data: Data Comm messages, traffic, weather, ATC audio, sector geometry, sector combine information, and TFM initiatives
    - ATC audio identify uplinks which occur between check-in and physically entering sector
  - Callsigns are removed before sharing
  - For illustrative purposes, all communications are categorized into groups such weather (wx), clearances, transfer of communications and check-in (TOC), etc.

Process for Identifying and Analyzing Scenarios (2/3)

- Sequences of verbal transmissions were categorized as "clearance"
- For example, all these transmissions were assigned as "clearance"

	Verbal	Data
Controller	I gotta give you that fix as well let me know when you're ready to copy	[UM80] CLEARED PNSLI REDFN Q105 HRV J58 AEX PNUTS.WHINY4 KDFW [UM169] ----- PNSLI REDFN Q105 HRV J58 AEX PNUTS.WHINY4 KDFW
Pilot	go ahead	WILCO
Controller	clear direct PNSLI papa november sierra lima india and then leeville	
Pilot	direct november sierra uh lima echo direct leeville	
Controller	no PNSLI is papa november sierra lima india	
Pilot	papa november sierra lima india	

Process for Identifying and Analyzing Scenarios (3/3)

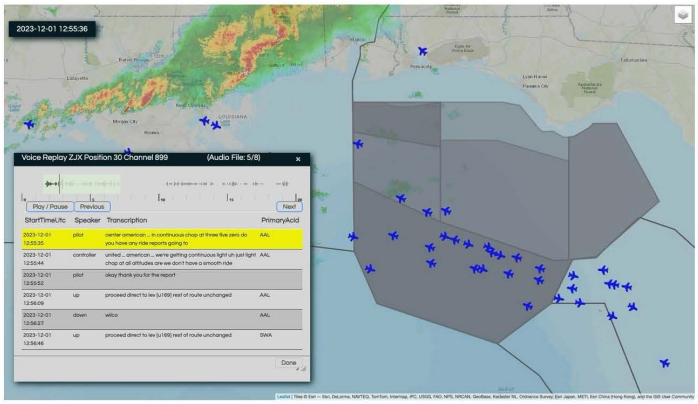
- Example of weather (wx) group

	Verbal	Data
Pilot1	how are the rides at three four zero	Not applicable
Controller	oh a uh it might be a little worse than thirty two um thirty two seems to be a little better but i got somebody south of <unk> and get your ride reports	
Pilot1	please because we're choppy at thirty two	
Controller	<callsign2> how's your ride at three four zero <callsign2> how is your ride at flight level three four zero	
Pilot2	we just started getting some light chop here in the clouds	
Controller	they're getting light chop, my guess is further to the northwest of your approach at from it's gonna continue be light chop	
Pilot1	I'd like to put uh three four zero on request	

Challenges to Conduct Analyses

- ATC Audio
  - In Spring 2024, FAA DRAAS (DALR Remote Audio Access System) server was upgraded
  - As a result, the time window allocated for MITRE to capture audio recordings for ~130 facilities was significantly reduced
    - Now less than 50% of the audio data can be captured before it disappears from the FAA system
    - This reduction creates substantial gaps in voice data and severely impacts ability to conduct comprehensive Data Comm (and other) analysis
- Limited access to Data Comm messages
  - MITRE's access to Data Comm messages is limited to specific requests for date/time
  - No identifying info on which sector uplinked the message
- Controllers have many options to achieve a goal
  - If insufficient time to deliver a clearance, multiple headings may be given

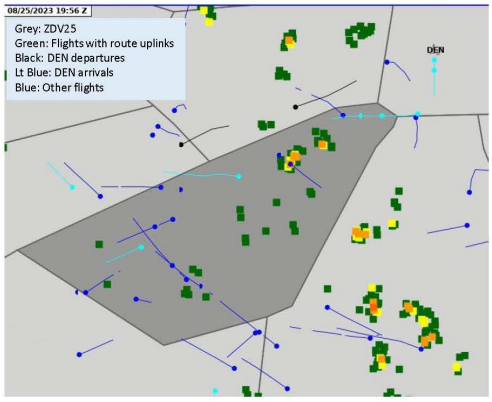
Traffic Visualization Tools (1/2)



- Displays verbal and uplinked clearances at appropriate times
  - Audio disabled to hide identify of flights
- Speed: real-time

Federal Aviation Administration

Traffic Visualization Tools (2/2)

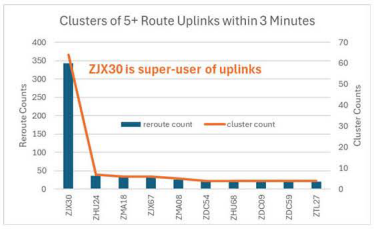


- Displays traffic and weather in a scenario in fast-time

Federal Aviation Administration

Sectors with Many Route Uplinks

- To identify clustered use of route uplinks, data between November 15, 2023 to September 15, 2024 was analyzed
- Graph shows top 10 sectors with groups of five or more CPDLC routes within the same sector, all within a three-minute time-period
- ZJX30 stands out as a super-user of route uplinks



ZJX30 has been using mobile frequency site since a storm knocked out the land-based comms "a while back". Weather can greatly affect the coverage.
From 15 March 2024 TMU log: ZJX30 HAD FREQUENCY ISSUES THAT LED TO ZJX IN ATC ALERT STATUS, ISSUE IS ONGOING.

Federal Aviation Administration

Scenarios Illustrating Operational Impact

- ZJX30 uplinks 5 routes in one minute
- ZMA08 uplinks 12 routes in an hour with nearby weather
- ZHU81 uplinks 15 routes in an hour with weather impacting ops

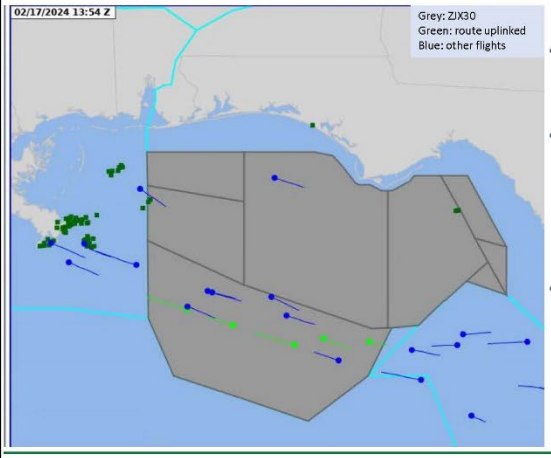
Federal Aviation Administration

Scenario 1: ZJX30 Uplinks 5 Routes in One Minute

2/17/2024

12

ZJX30 Uplinks 5 Routes in One Minute



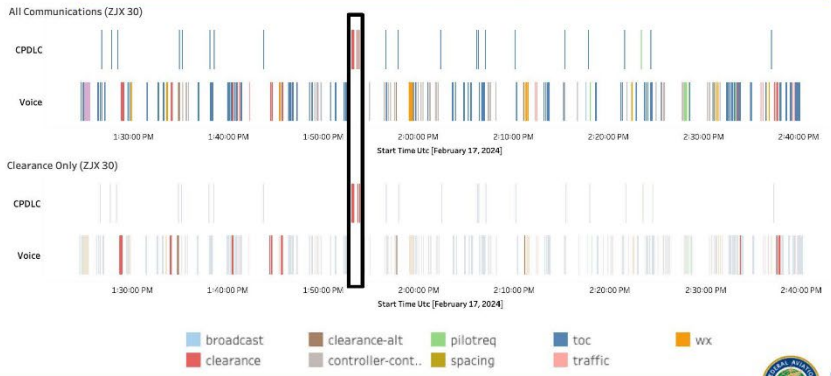
- ZJX30 frequently uplinks routes to flights in quick succession
- Controller at ZJX30 uplinked five route clearances to five different aircraft in under 60 seconds using CPDLC
- CPDLC equipage rate: 52%

14

Federal Aviation Administration

ZJX30 Uplinks 5 Routes in One Minute

ZJX30 Controller uplinks 5 direct to fix clearances
in less time (60 seconds) than by voice (95 seconds)



15

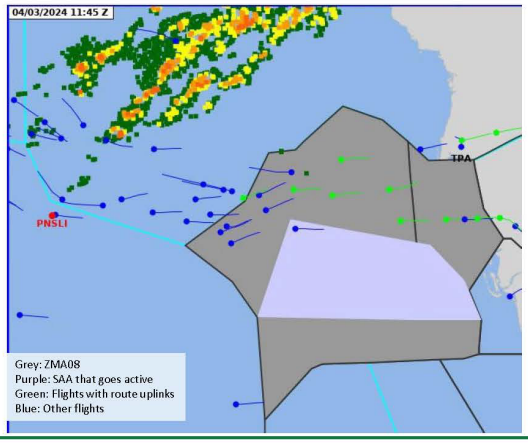
Federal Aviation Administration

Scenario 2: ZMA08 Uplinks 12 Routes in an Hour

4/3/2024

15

ZMA08 Uplinks 12 Routes in an Hour

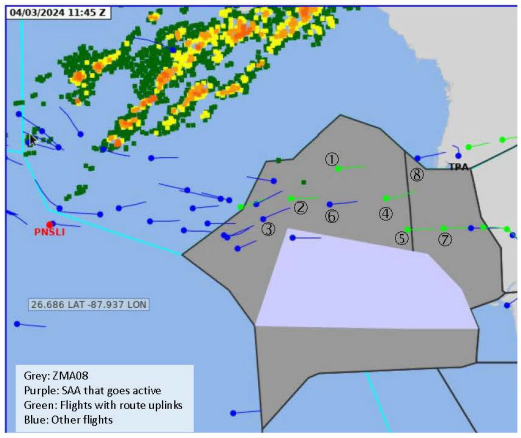


- 1145Z Westbound flights were to be cleared over PNSLI (red fix). In 20 minutes, controller
  - Uplinked 9 PNSLI reroutes
  - Issued 7 verbal PNSLI reroutes which included 12 spellings of PNSLI on frequency
- Issued reroutes/descents for eastbound flights
- Starting 1210Z: Supports flights in/out of warning area
- 1230Z: Supports flight diverting due to turbulence injuries
- CPDLC equipage rate: 46%

Federal Aviation Administration

17

ZMA08 Uplinks 12 Routes in an Hour



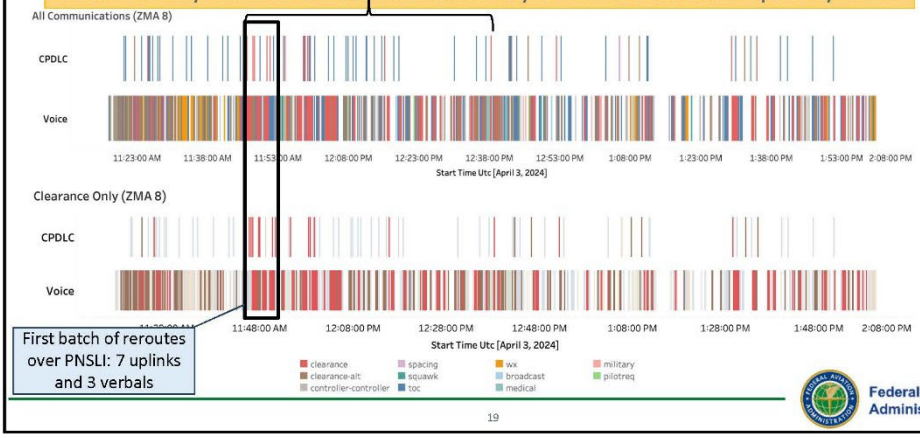
- Order of PNSLI clearances
  - Majority of initial flights get uplinks
- Uplink was preferred over verbal for all route clearances in this sector
  - Only 30% of the verbal clearances that included a route were for flights that filed for CPDLC
    - However, most of those verbal clearances were "direct to fix" on frequency check-in or ineligible for uplink (e.g., descend via clearances or multi-dimensional)

Federal Aviation Administration

18

ZMA08 Uplinks 12 Route Amendments in an Hour

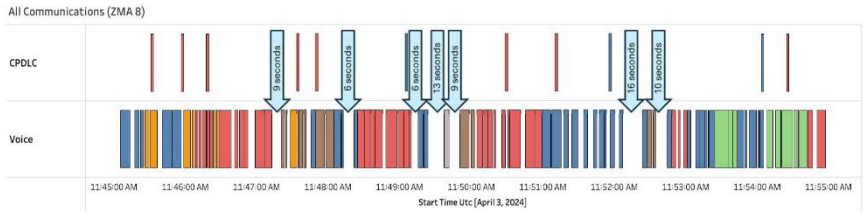
ZMA08 uses mix of uplinks and verbal clearances to implement reroute under heavy traffic conditions with many TOCs to reduce frequency time



Federal Aviation Administration

19

ZMA08: Closeup of 10 minutes of PNSLI Reroute



- 10 reroutes over the fix PNSLI are cleared in 10 minutes along with other sector communications
  - Uplinks occur during other verbal communications
  - Verbal PNSLI route clearance averages 39 seconds
  - Only 71 seconds of unused frequency exists in these 10 minutes

clearance
clearance-alt
controller-co..
spacing
squawk
toc
wx
broadcast
medical
military
pilotreq

Without Data Comm

- Less than 5 of the 10 PNSLI reroutes would have been delivered in the 10 minutes
- Last PNSLI reroute would have been delivered at least 3:15 later without Data Comm assuming no other communications were needed, but frequency is in continuous use

Federal Aviation Administration

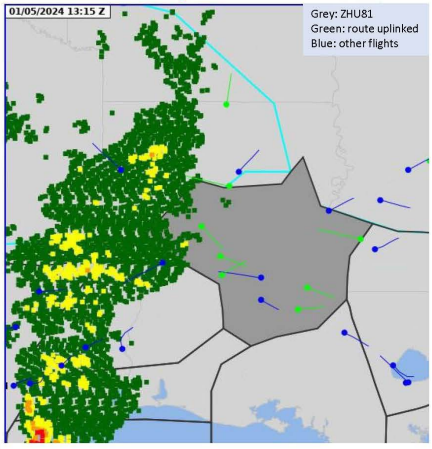
20

Scenario 3: ZHU81 Uplinks 15 Routes in an Hour Around Weather

1/5/2024

20

ZHU81 Uplinks 15 Routes in an Hour

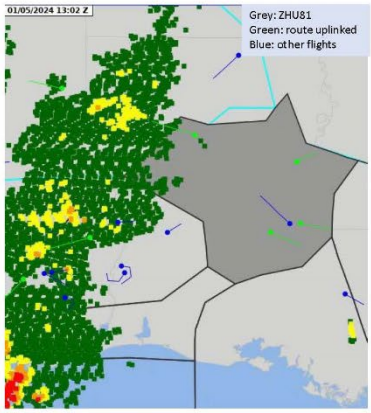


- Houston Center was extremely busy dealing with reroutes, delays and holding due to the line of thunderstorms within the area.
- Controllers were supporting internal traffic management initiatives (TMIs) to help avoid a possible ground stop from the weather
- ZHU81 rerouting traffic through gaps in weather to northwest arrival fix into Houston airports
  - Verbal reroutes involved spelling fixes: "direct Leona that's lima oscar alpha then direct MMAXX mike mike alpha x-ray x-ray for the KIDDZ4 arrival"
- CPDLC equipage rate 63%

22

Federal Aviation Administration

ZHU81 Uplinks 15 Routes in an Hour

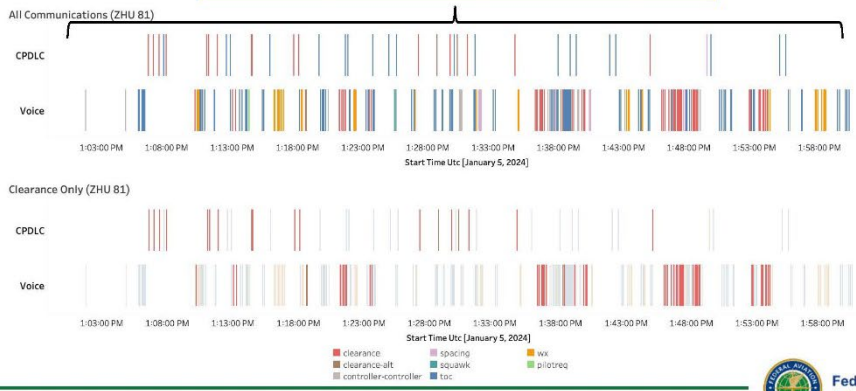


- Westbound flights and Northwest bound flights are rerouted around weather

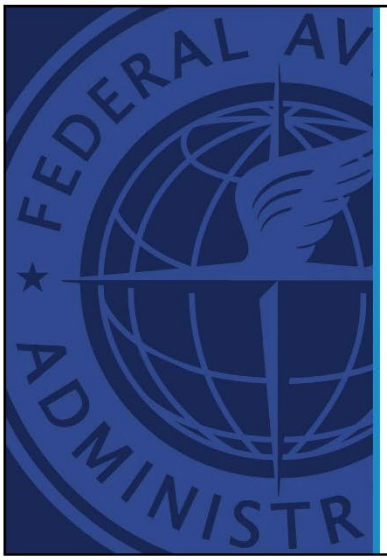
Federal Aviation Administration

ZHU81 Uplinks 15 Routes in an Hour

ZHU81 used uplinks to reroute flights around and through the weather



Federal Aviation Administration



Future Analyses

Future Analyses

- Continue to find examples that support the "big data" savings number
- Examine correlation with sector equipage rates and benefits
  - Unlike PBN, Data Comm benefits can accrue with low sector equipage rates, but denser equipage has greater impact
- Begin examination Data Comm impact on severity of Traffic Management Initiatives (e.g., Miles-in-Trail, Ground Stops, etc.)
  - Challenging as it's hard to find "like" traffic/weather days for comparison

Federal Aviation Administration

Appendix F: A4A Operations Council Survey Results

Airlines for America®

We Connect the World

Background

In August, Lee Brown (B6), Eric Silverman (AA), Andy Cebula (A4A) met with members of the A4A Operations Council for a discussion and background of the NAC JAT, including a review by carriers of the current state of the effectiveness of EnRoute DataComm deployment. The purpose was to provide an initial conversation and review survey questions for use in obtaining qualitative responses from operators to provide perspectives on state of deployment and use.

The survey was subsequently emailed with A4A receiving replies from 9 but 10 A4A members participating. (Only non-respondent does not operate a US network.)

Question 1

Has the use of the equipment been fully implemented into your flight crew training program? If not, what are the barriers to incorporating into your training program?

All A4A members have implemented the use of DataComm into training programs, including ground school and simulator sessions (except for certain aircraft that do not have DataComm capabilities). There is a desire to enhance the correlation between simulator training and real-world operational experiences. While not specifically asked, several respondents volunteered that the training has also been incorporated into dispatcher training.

Question 2

How would you describe the responses from flight crews to EnRoute DataComm (e.g. like it and value it, view as another piece of tech that isn't worth the effort)?

Flight crews overwhelming value the use of DataComm to replace certain voice transmissions when it functions as intended. However, issues with transmission of message, and identified problems being addressed by the DCIT and NWIG can create frustration and dampen enthusiasm for its use (i.e. duplicate fix, block list). There is also a desire that it be fully deployed at all centers.

While not specifically asked, several respondents shared that tower CPDLC is an important cockpit tool and viewed positive.

Question 3

How have the dispatchers/opns center staff responded to the availability of EnRoute DataComm?

Most A4A members have made EnRoute DataComm available to dispatchers and operational staff and have received positive feedback based on the shared information and the ability to incorporate this into flight planning, fuel calculations, and associated dispatch and Ops Center roles. Several respondents stated no specific positive or negative feedback from dispatchers/opns center staff.

Question 4

How has EnRoute DataComm impacted your operations in convective weather events?

Responses were varied with many expressing positive value, although others stated weaknesses. Extracts from replies offer context:

- "…when this is working as it should, this reduces both Pilot and Controller workload…"
- "…the ability to receive both altitude, waypoint, and loadable clearances directly mitigates the risk of readback errors and enhances efficiency by allowing the route to be loaded directly into the aircraft's FMS…"
- "…DataComm is time consuming as it involves selection of FMS menus, selecting appropriate message types, typing and entering free text, etc., rendering it less efficient or ineffective for more time critical pilot-controller communications/coordination."
- "…there is still some confusion on certain reroute message sets for wx that have been misinterpreted resulting in potential pilot errors…"

Question 5

How has EnRoute DataComm impacted your operations in high air traffic events?

Similar to the convective weather responses, most operators expressed the positive value of reducing frequency congestion and readback errors between flight crews and controllers during high traffic; with the caveat that EnRoute DataComm has the previously stated current limitations. Two replies expressed no additional value of DataComm versus voice.

Question 6

As a senior leader, what is your overall impression of EnRoute DataComm?

The following excerpts provide insight into the mixed view on EnRoute DataComm in September 2024.

"…overall impression of Enroute DataComm has been positive, however there are some issues that still need to be resolved. We look forward to FAA completing roll out of Domestic CPDLC Enroute coverage across continental U.S…"

"…has potential but is hampered by all of the operational and technical challenges that exist today..."

"…the value derived from equipage is dwarfed by the cost…"

"…overall impression of enroute data comm is very favorable. The safety and efficiency benefit it brings to enroute operations have already proven valuable. As the program continues to expand and some of the existing issues are addressed, I believe these benefits will become even more evident over time…"

"…there are challenges in defining the cost-benefit of the program, particularly concerning hardware requirements and troubleshooting. Despite these challenges, the ongoing improvements will further enhance the system's positive impact on our operations..."

"…it is a positive program that has promise to get better. Aircraft have avionics and equipage issues, which can be reduced but will unlikely be resolved in its entirety…"

"…DataComm has added significant clarity in communications while eliminating interrupted or blocked radio transmissions contributing to safety enhancements throughout aviation operations…"

"…DataComm mitigates confusion when controllers are working multiple sectors/utilizing multiple radio frequencies. However, the autonomous communications using DataComm may also reduce or remove situational awareness of other flight operations within the same operating space…"

"…while there is some limited safety improvement from clearance / read back errors, enroute data comm has not delivered on the promise of combining w nav and surveillance to reduce spacing and increase throughput in the NAS.

"…avionics issues: After participating in program, it was discovered that certain Avionics were not performing as intended. Operators were then required to update their avionics, in order to remain in the Enroute CPDLC program…"