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Aircraft Access to SWIM (AAtS) Concept of Operations (ConOps)

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Submitted by:

Booz | Allen | Hamilton

8255 Greensboro Drive
McLean, VA 22102

Date: July 31, 2013

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Aircraft Access to SWIM (AAtS) Concept of Operations (ConOps)

Developed for:
Angel Morales
Federal Aviation Administration
Technical Analysis & Operational Requirements Group (AJV-73)

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Executive Summary

This Aircraft Access to SWIM (AAtS) Concept of Operations (ConOps) document builds on the Concept of Use (ConUse) document developed in fiscal year 2012. The ConUse focused on the uplink of tailored, on-demand, digital National Airspace System (NAS) information to flight crews through authorized service providers using an interface to a common infrastructure – System Wide Information Management (SWIM). This document will re-iterate this concept, while incorporating the next phase focusing on the downlink of relevant data from the aircraft and flight crews to stakeholders internal and external to the Federal Aviation Administration (FAA).

The Next Generation Air Transportation System (NextGen) introduces numerous methodologies and technologies that will enhance the NAS in order to accommodate the predicted increase in air traffic by 2025. AAtS is one of these enabling technologies aligned to the NextGen solution set, Collaborative Air Traffic Management (CATM), which will contribute to this enhancement. AAtS will directly help satisfy five Operational Improvements (OIs) supporting CATM.

These OIs, developed by the FAA, are meant to satisfy an operational need and can be linked to several shortfalls identified in the current NAS. For example, there is limited or no real-time access to Traffic Flow Management (TFM) and aeronautical information for flight crews onboard the aircraft. And there is no authoritative source for weather data. Today's system is inefficient and heavily reliant on voice communications. Also, air traffic management personnel do not have real-time access to aircraft and/or flight crew generated flight information (e.g., flight performance profile[1]) and weather information (e.g., atmospheric conditions). In general, there is little common situational awareness between flight crews and ground operations[2].

AAtS is a bi-directional data link connecting aircraft and flight crews to ground operations for the purpose of exchanging advisory[3] information. AAtS will be technologically flexible, but will leverage existing NAS infrastructure including SWIM's service oriented architecture, the FAA telecommunications infrastructure network, and NAS boundary protection services. The FAA will provide the appropriate data access enabled by SWIM to approved commercial vendors via the NAS boundary protection services. It is then up to the discretion of those vendors which customers receive this data, how they receive it, and how it is packaged to provide relevant information to the end-user. Aircraft systems and flight crews will also provide a down-link of relevant data to the FAA via the commercial data link. This will include both automated and

[1] "Flight performance profile" is the comprehensive data set describing the planned flight profile (i.e., 4DT) versus the actual flight profile, including how and why the two profiles differ (e.g., what caused a flight crew to divert to an alternate airport and who initiated the diversion).
[2] "Ground operations" is an encompassing term that may include FAA facilities (ARTCCs, TRACONs, ATCSCC, ATCTs, AFSS/FSS, etc.), airport authorities/operations, and operations centers (AOCs/FOCs).
[3] The term "advisory", used in this manner, is not necessarily synonymous with ATM advisories such as TMIs issued by the ATCSCC. "Advisory" information is defined as supplemental information that is not necessary for command and control of an aircraft.

manually input data used to better inform TFM and weather models and feed learning-capable decision support tools.

The major change AAtS introduces to the exchange of advisory information is the transition from a primarily voice dependent, untimely process to a system in which on-demand access to near real-time information is the norm. Currently, advisory information is the lowest priority transmission category for exchange on safety critical aviation frequencies used by Air Traffic Control (ATC) for the purposes of separating aircraft.

There will be limited change required to the current operational environment (i.e., facilities and infrastructure). And although the culture of collaboration and decision making may be transformed, there will be no required procedural changes for ATC and pilot exchanges (i.e., command and control). AAtS will not be considered critical for operations; rather it will be used to support operational strategies and decisions.

In order for AAtS to function as envisioned, it is assumed the FAA will adopt SWIM as the primary mechanism for data exchange within the NAS. This will ensure a robust collection of information for end-users. The FAA will also have to rely on cooperation with vendors and end-users to ensure their receipt, via AAtS, of relevant data from aircraft and flight crews.

Because of its technological flexibility, AAtS should encourage the FAA’s efforts for global harmonization and interoperability among international Air Navigation Service Providers.

Full implementation of AAtS capabilities in the far-term NextGen environment will contribute to the realization of several NextGen benefits. Evidence of these benefits are shown via nine event-driven operational scenarios presented in this document and include improved information distribution and access, improved predictability, increased flexibility, increased efficiency, increased access, increased capacity, enhanced safety, reduced fuel-burn and engine emissions, increased user-preferred routing, and improved operations capability analysis.

AAtS concept development continues at the time this ConOps is released. The final ConOps will be released in Fiscal Year 2014.

1 Introduction/Scope

This Concept of Operations (ConOps) document is a continued activity in the concept development of Aircraft Access to SWIM (AAtS). The AAtS concept is being researched and validated in a two phased approach. In Fiscal Year 2012 an AAtS Concept of Use (ConUse) document was developed to address *phase one*. Phase one focused on the uplink of tailored, on-demand, digital National Airspace System (NAS) information to flight crews through authorized service providers using an interface to a common infrastructure. This phase primarily satisfies operational improvements in the mid-term (2015-2018) and is expected to be implemented during that timeframe.

This ConOps presents further development of the concept by introducing *phase two*. Phase two focuses on incorporating the downlink of information *from* the aircraft and flight crews to stakeholders internal and external to the Federal Aviation Administration (FAA). This phase satisfies operational improvements in the mid-term and far-term (2015-2025) and is expected to be implemented during that timeframe. Although this document builds on the previous ConUse, it will explore AAtS as one complete concept; henceforth the terms *phase one* and *phase two* will no longer be used.

The concept in this document is presented with respect to current information systems and procedures; as well as those anticipated to exist in the far-term (2018-2025) Next Generation Air Transportation Systems (NextGen).

1.1 Background

The FAA is transforming the NAS by introducing NextGen to accommodate the predicted increase in air traffic by 2025. NextGen will increase efficiency and capacity through more predictability of NAS operations, while increasing safety. The transition to NextGen requires capabilities and technologies that enable more advanced operations, including streamlined data communications and information exchange. The NextGen initiative is organized into seven solution sets, each containing interdependent projects that work together to provide these capabilities to targeted user groups [1]. AAtS falls under the Collaborative Air Traffic Management (CATM) solution set. The following Operational Improvements (OI), with the associated timeframe for initial operating capability in parentheses, are aligned to the CATM solution set and have also been identified as the fundamental OIs that AAtS will directly support [2]:

101102 Provide Full Flight Plan Constraint Evaluation with Feedback (2013-2018)

103305 On-Demand NAS Information (2013-2018)

105207 Full Collaborative Decision Making (2017-2023)

105302 Continuous Flight Day Evaluation (2012-2018)

108212 Improved Management of Special Activity Airspace (2012-2017)

For detailed descriptions of these OIs, please refer to the NAS enterprise architecture portal (https://nasea.faa.gov).

1.2 Problem Statement

System Wide Information Management (SWIM) will provide an open, flexible, and secure information management architecture for sharing NAS information among stakeholders [1]. However, the SWIM program does not currently address the link between airborne systems and SWIM-enabled ground-based systems.

In general, the exchange and access to information between flight crews and ground operations[4] is often imbalanced. Specifically, flight crews do not have access to a common, shared information platform to fulfill their advisory[5] information needs onboard the aircraft. The information is not available on demand or in real-time. This prevents pilots and their supporting operation from making informed decisions and hampers their ability to strategically plan.

Furthermore, ground-based systems and traffic managers do not have a common, efficient mechanism to obtain real-time information updates about a specific flight, its operation, and its surrounding airspace conditions. These shortfalls inhibit the predictability, flexibility, and efficiency of the entire NAS and have motivated the FAA's exploration of AAtS.

1.3 Concept Overview

AAtS is an air-ground solution that will leverage the SWIM infrastructure to give flight crews access to relevant, NAS data. The data delivered to flight crews via AAtS will come from a common infrastructure – SWIM. However, not all SWIM data will be available through AAtS in order to protect proprietary information and security. The information that will be available will increase common Situational Awareness (SA) between flight crews and ground operations, while promoting strategic planning and more informed decision making. AAtS will also be the mechanism that will afford airspace users the ability to provide near real-time input, such as atmospheric conditions, to ground operations and systems. Together, this timely, bi-directional communication link will help create a shared NAS picture and is expected to contribute to increased predictability, flexibility, and efficiency within the NAS.

[4] "Ground operations" is an encompassing term that may include FAA facilities (ARTCCs, TRACONs, ATCSCC, ATCTs, etc.), airport authorities/operations, AFSS and operations centers (AOCs/FOCs).
[5] The term "advisory", used in this manner, is not necessarily synonymous with ATM advisories such as TMIs issued by the ATCSCC. "Advisory" information is defined as supplemental information that is not necessary for command and control of an aircraft.

Figure 1 NextGen Far-Term Air-Ground Information Exchange

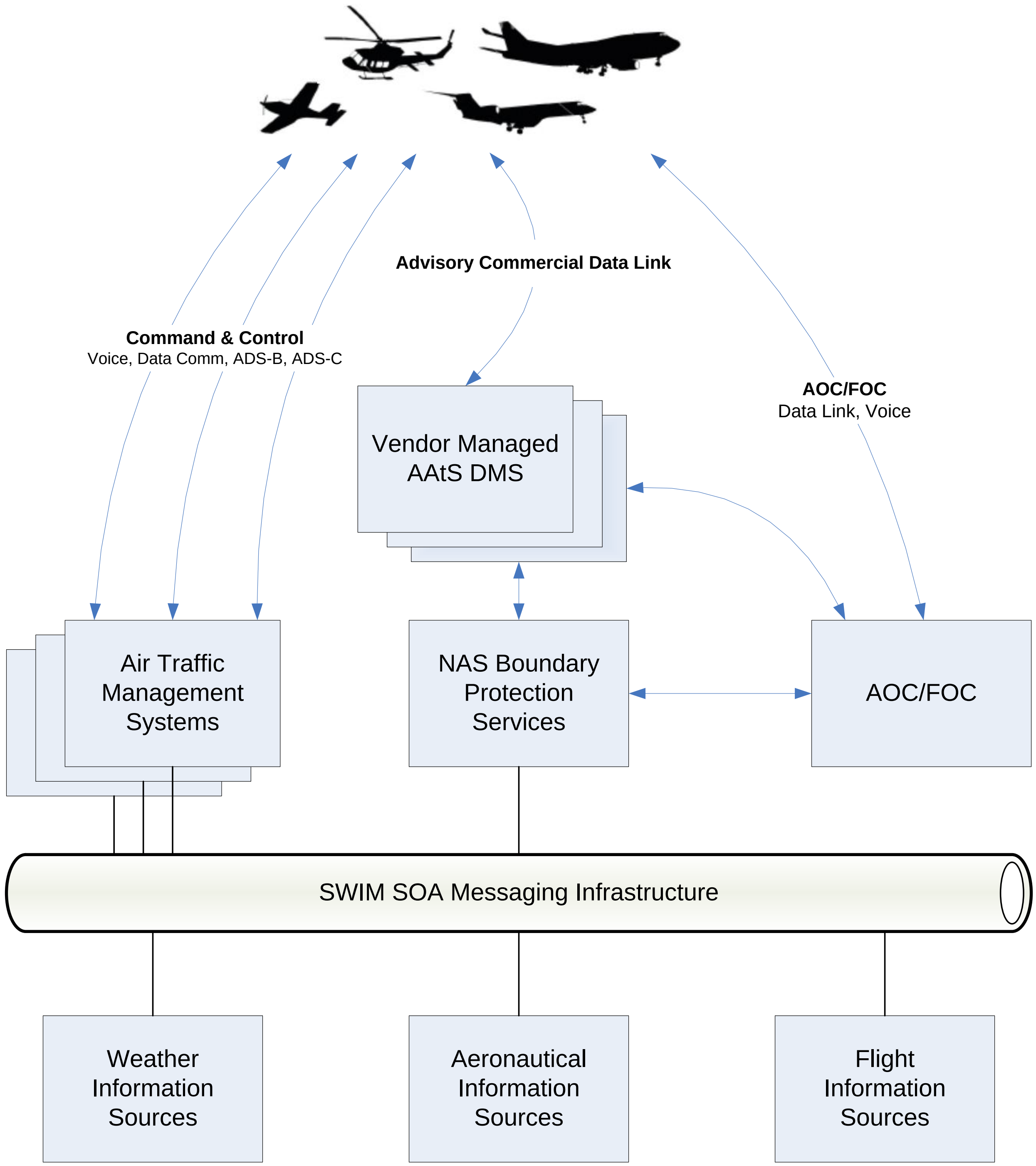

Figure 1 is a “to-be” representation of air-ground information exchange in the far-term NextGen environment including the important role AAtS will fill. On the left side of the figure, primary command and control methods are depicted (e.g., voice). The middle of the figure portrays the bi-directional commercial data link via AAtS used solely for advisory information. The Airline Operations Center (AOC)/Flight Operations Center (FOC), pictured here, may receive advisory information through AAtS via the vendor managed AAtS Data Management Service (DMS). The DMS is a vendor(s) managed service accessing raw SWIM data that will manage, filter, validate and distribute relevant information in a usable format to customers. The AOC/FOC may also receive advisory data directly via the NAS boundary protection services. In this case, the AOC/FOC acts as their own DMS.

2 Current Operations and Capabilities

The following shortfalls exist in the current NAS operation:

- Lack of a shared, authoritative NAS-sourced data between ground operations and flight crews
- Lack of real-time Traffic Flow Management (TFM), weather and aeronautical information for flight crews onboard the aircraft
- Heavy reliance on voice communications for advisory information exchange
- General Aviation (GA) pilots are at a disadvantage to airlines in terms of advisory information availability; especially those without operations center support
- Air Traffic Management (ATM) personnel and systems do not have real-time access to individual flight information generated by aircraft (e.g., flight performance profile[6]) or flight crews (e.g., surface movement data)
- ATM personnel and systems do not have real-time access to weather information generated by aircraft (e.g., atmospheric conditions) or flight crews (e.g., Pilot Reports (PIREPs))
- Lack of decision support automation for NAS operations planning

These shortfalls will be highlighted in the subsequent sections by providing a description of flight, weather, and aeronautical information exchange today. The focus will be on information from ground-based services and products that are not on-demand, un-timely, or completely unavailable to flight crews. *Note: This section does not provide an exhaustive list of information services and products*. A description of the relevant supporting infrastructure currently in place will also be described. Lastly, the relationships/procedures among NAS users (pilots, controllers, dispatchers, traffic managers, etc.) interacting with the current operation as it relates to AAtS will be presented.

2.1 Current Information Exchange

Information exchanged between NAS users can be categorized into three primary information domains; flight, weather, and aeronautical. Each domain has an associated exchange model used as a mechanism for sharing this information; Flight Information eXchange Model (FIXM),

[6] "Flight performance profile" is the comprehensive data set describing the planned flight profile (i.e., 4DT) versus the actual flight profile, including how and why the two profiles differ (e.g., what caused a flight crew to divert to an alternate airport and who initiated the diversion).

Weather Information eXchange Model (WXXM), and Aeronautical Information eXchange Model (AIXM). The following sections will highlight how this information is created, distributed, and used. The way in which this information works together in the operations planning decision process is also described.

2.1.1 Flight Information – Traffic Flow Management

The term TFM encompasses a wide range of functions; from long term planning to accommodate scheduled events to short term implementation of Traffic Management Initiatives (TMI) used to manage system imbalances between demand and capacity. In general, the highest level of planning occurs at the Air Traffic Control System Command Center (ATCSCC) in Vint Hill, Va., although TFM is performed at all Traffic Management Units (TMU) around the country.

For a special event (e.g., Super Bowl) with a major impact on the NAS, a detailed impact statement and plan are developed well in advance of the event by the FAA (ATCSCC and other facility TMUs). On the day of the event, the ATCSCC will then publish an advisory and review that plan during the Operational Planning Telephone Conferences (TELCONS).

During periods of unplanned events (e.g., convective weather event) with a major NAS impact, the ATCSCC disseminates information to ground facilities including Air Route Traffic Control Centers, select Terminal Radar Approach Control (TRACONs) facilities, and AOCs/FOCs as it becomes available through published advisories, direct phone calls, or during TELCONs. The ATCSCC distributes these advisories identifying the techniques used to mitigate the extent of the impact. The techniques used by the ATCSCC are in the form of TMIs. *Note: The ATCSCC is not the only facility that may issue a TMI; however, local TMUs have limited authority in this function*. TMIs implemented by ATM include:

- Ground Stops (GS): Procedure requiring all aircraft meeting specific criteria to remain on the ground. The GS may be airport specific, related to a geographical area, or equipment related [3]
- Ground Delay Program (GDP): Procedure which aircraft are delayed at their departure airport in order to manage demand and capacity at their arrival airport [3]
- Miles-in-Trail (MIT): The number of miles required between aircraft departing an airport, over a fix, at an altitude, through a sector, on a route, or destined for a specific airport. MIT is used to apportion traffic into a manageable flow, as well as provide space for additional traffic (merging or departing) to enter the flow of traffic [3]
- Minutes-in-Trail (MINIT): The amount of time needed between successive aircraft. Normally used when aircraft are operating in a non-radar environment [3]
- Flow Evaluation Area (FEA): A volume of airspace used to identify flights subject to a potential constraint [3]
- Flow Constrained Area (FCA): A volume of airspace used to identify flights subject to an actual constraint requiring action to address the particular situation [3]

- Airspace Flow Program (AFP): A tool assigning specific arrival slots and corresponding Expect Departure Clearance Times (EDCTs) to manage capacity and demand for an FCA
- Reroutes: Used by traffic flow managers to route aircraft in order to:
    - Ensure aircraft operate with the flow of traffic
    - Remain clear of Special Activity Airspace (SAA)
    - Avoid congested airspace
    - Avoid areas of known weather
- Altitude Restriction Capping/Tunneling or Low Altitude Arrival/Departure Routing: All forms of altitude restricted flight used normally in the arrival or departure phase of flight
- Fix Balancing: Assigning an aircraft a fix other than in the filed flight plan in the arrival or departure phase of flight to equitably distribute demand [4]
- Airborne Holding: Planned holding of aircraft may be utilized. This is normally done when the operating environment supports holding and the weather conditions are expected to improve shortly; this ensures aircraft are available to fill the capacity at the airport [4]
- Sequencing Programs: These programs are designed to achieve a specified interval between aircraft; they may be software generated or determined by TM personnel. Different types of programs accommodate different phases of flight [4]

Under normal operations, flight crews are unaware of TMIs being executed by ATM. They are only realized through instructions issued to them by Air Traffic Control (ATC). For example, pilots may not be aware of a reroute until ATC assigns them a new route. Or the flight crew may not be aware of compacted arrival demand at an airport until it impacts their flight. However, ATC will sometimes warn pilots, for example, to expect holding instructions at a given Very High Frequency Omnidirectional Range (VOR) due to volume at an airport.

2.1.2 Weather Information

Today, flight crews' most valuable in-flight weather tool is their on-board weather radar (provides real-time, limited conical view of weather in front of aircraft). Through radio communication, flight crews receive weather information directly from ATC referencing any number of their own ground-based weather displays. Pilots also receive weather information indirectly from other aircraft via ATC. Lastly, it is common for GA pilots to subscribe to any number of pay-for weather services provided by a vendor or utilize the FAA's free Automated Flight Service Station (AFSS).

Additionally, weather conditions impact takeoff and landing. Pilots receive weather information from the flight plan briefing, but cannot view real-time weather information, via their on-board weather radar, until they reach the active runway. Pilots receive weather information via Automatic Terminal Information Service (ATIS) broadcasts and PIREPs. However, PIREPs are not added to the system in a timely manner. For example, today a pilot will convey some weather anomaly to an en-route controller through the appropriate frequency. The controller is then responsible for relaying this message (PIREP) to his or her supervisor. Then the supervisor will inform the Center Weather Service Unit (CWSU) of the PIREP. Finally, the CWSU is responsible for entering the PIREP into the distribution system. Meanwhile, each of these steps in this process is workload dependent.

Weather data used in forecasting and modeling comes from various sources, some of which have shortfalls in their ability to continuously update their forecast. For example, measurement of atmospheric conditions is dependent on data from just twice-a-day weather balloon launches at 92 locations across the United States[7]. This, along with surface observations, radar, and previous model outputs help create the various weather products and services used in the operation of the NAS. These products and services include:

- Next Generation Weather Radar System (NEXRAD): A network of high-resolution Doppler weather radar that displays patterns of precipitation and precipitation movement
- Terminal Doppler Weather Radar (TDWR): Used primarily for the detection of hazardous wind shear conditions and high-resolution precipitation data on and near major airports
- Integrated Terminal Weather System (ITWS): Provides information/products including, but not limited to Airport Lightning Warning, Configured Alerts, Forecast Accuracy, Forecast Contour, Gust Front TRACON Map, Microburst TRACON Map, Precipitation 5 nautical miles, Precipitation Long Range, Tornado Alert, Wind Profile, Microburst ATIS, Storm Motion TRACON, and Wind Shear ATIS
- Corridor Integrated Weather System (CIWS)[8]: Provides information/products including but not limited to Vertically Integrated Liquid Mosaic (1kilometer resolution); storm information such as Motion Vectors, Echo Tops Forecast Contours, Growth & Decay Contours; and Forecast Accuracy - Winter Precipitation
- Automated Surface Observing System/Automated Weather Observing System (ASOS/AWOS): Automated surface units that measure and report weather elements at the airport including Sky condition up to 12,000 feet and visibility (to at least 10 statute miles); precipitation; obstructions to vision such as fog and haze; pressure including sea-level pressure and altimeter setting; temperature; wind including direction, speed, and character; and precipitation accumulation

2.1.3 Aeronautical Information Management

Notices to Airmen (NOTAM) deliver information such as the operational status of airport systems, runways, and navigational aids. The United States NOTAM System manages and disseminates US NOTAMs. NAS Aeronautical Information Management Enterprise System (NAIMES) is responsible for the secure management of *all* real-time operational aeronautical information. Ground operations have real-time access to NAIMES.

[7] Some airlines today do collect atmospheric conditions using their aircraft's sensors for forecasting and modeling purposes, however, this data is only shared internally.
[8] CIWS is currently a prototype system used in an operational setting.

Today, pilots do not receive real-time aeronautical information. The aeronautical information they do receive may be limited, outdated, or incomplete to the extent that it does not give pilots the necessary time to consider alternatives. For example, a NOTAM may be issued indicating a closed runway at a particular airport. An aircraft approaching that airport may be given holding instructions by an en-route controller (not located in the sector of the arrival airport), because of the reduced arrival rate due to the closed runway. The reduced arrival rate at the airport was ultimately the driver behind the hold instruction, unbeknownst to the pilot and possibly the controller. It is common place for ATC to inform pilots about a NOTAM only when they deem it significant and are actually aware of it themselves. Otherwise, pilots receive NOTAMS from alternate sources such as their AOC, an AFSS, or ATIS (when the NOTAM is affecting the terminal area).

Flight crews do not have the ability to maintain real-time awareness of SAA. For example, a flight crew may not be notified that previously active SAA is now useable. As a result, the flight crew may not fly their most optimal route. Furthermore, the under-utilization of airspace, when multiplied throughout the entire NAS, can lead to a less efficient operation.

2.1.4 Operations Planning Decision Process

Currently, the decision process for TFM is a complex one which lacks consistency. Forecasted weather, planned traffic, and equipment status information is gathered from various sources to form an overall picture of the NAS. Using this information, traffic managers use their own knowledge and experience to determine the impact a particular situation will have on the NAS. Then a decision is made to issue a TMI, for example, based on their assessment of that impact. Today, there is no automated information exchange feeding a learning-capable Decision Support Tool (DST) that aids in the decision that is executed. The problem arises because human attributes such as personal experience, perspective and thought process can differ among the individuals making these assessments, as well as within one’s self on a day-to-day basis.

2.2 Current Supporting Infrastructure

The manner in which advisory information is exchanged among ground operations today is based on a point-to-point, labor intensive system. SWIM is currently in the process of contributing to the modernization of this system by applying a Service Oriented Architecture (SOA) approach. This, along with the rest of the FAA and industry’s infrastructure in place today is foundational for the implementation of AAtS. The following sections discuss that infrastructure.

2.2.1 System Wide Information Management

SWIM is being implemented in segments. In Segment 1, SWIM sponsored the development of a number of NAS capabilities as services compliant with established industry standards in order to interoperate in a SOA. Flight information services designated as SWIM Segment 1 includes flight data, terminal data, flow information, runway visual range data, and re-route data.

Weather information designated as SWIM Segment 1 includes CIWS, ITWS, and PIREP data. Aeronautical information designated as SWIM Segment 1 includes automated SAA data [1].

The FAA is currently implementing SWIM Segment 2. Core services will be added incrementally as required to support the implementation capabilities associated with all future services. SWIM core services provide enterprise messaging infrastructure to enable systems to request and receive information when they need it, subscribe for automatic receipt, and publish information and services as appropriate. This will provide for sharing of information among diverse systems [1].

2.2.2 FAA Telecommunications Infrastructure

The FAA's Telecommunications Infrastructure (FTI) is the primary provider of FAA telecommunications services and it forms the basic infrastructure for NextGen. The FTI network supports NAS operations by providing the connectivity required by systems including the Traffic Flow Management Systems, the Standard Terminal Automated Replacement System, and the Wide Area Augmentation System. In addition, applications like e-mail, internet, payroll, and other administrative services are provided by the FTI Mission Support Network. FTI provides an enterprise-wide approach to information security assurance. It meets the latest government standards for information security, and offers improved security services, like encryption [1].

2.2.3 NAS Boundary Protection Services

In place today are NAS boundary protection services (i.e., NAS Enterprise Security Gateway). This is designed to provide a secure interface between external users and NAS data and systems.

2.3 Current Procedures

The following sections describe the means by which pilots receive advisory information from the various actors in the NAS.

2.3.1 Pilot – Air Traffic Control

Pilots and ATC exchange of advisory information is primarily conducted via radio communication. Upon reporting on the frequency to a new sector or facility, a controller will respond to the pilot with advisory information if available and able (in terms of workload). Several problems surrounding radio communication exist including blocked transmissions, line-of-sight limitations, and hardware failures that often remain undiscovered until the next occasion for communication arises. According to the National Aeronautics and Space Administration's Aviation Safety Reporting System, most communication problems involve human error such as misinterpretation, error in content, ambiguous phraseology, incomplete content and untimely transmissions [5]. Also, during periods of major NAS impact when flight crews are in need of additional information, the ATC frequencies are congested due to command and control actions.

A positive attribute of radio communication today is a pilot's ability to monitor a communication frequency. This can provide useful information, for example, about traffic flow, location of traffic, and atmospheric or performance issues aircraft are encountering ahead. GA pilots make extensive use of this practice, particularly at non-towered airports or lower activity tower controlled airports.

2.3.2 Pilot – Operations Center

This section is divided further to delineate between different flight operation classifications and their respective support centers, or lack thereof.

2.3.2.1 Airline Pilot – Airline Operations Center

Information for the purposes of strategic planning is disseminated to airline pilots through their own AOC. Like ATC, the primary means for dissemination is through radio communication via dispatchers. These dispatchers can handle up to twenty flights at a given time. Once again, frequency congestion is highest during periods of major NAS impact. Aircraft Communication Addressing and Reporting System (ACARS), a digital data link used for simple messages, is also used as a means of communication between flight crews and their respective operations support.

In addition, a dispatch release is created for each airline's flight by a dispatcher. The dispatch release is the means by which the dispatcher communicates the details of a flight to the flight crew including aircraft type, routing, weather conditions, operating weights, etc. This information is available to the flight crew approximately an hour before their estimated departure time and can be retrieved online, faxed, or dictated via telephone or radio. Based on agreed upon terms, the flight crew and dispatch have the ability to amend a dispatch release throughout the flight based on a new route of flight, for example.

2.3.2.2 General Aviation (Supported) – Flight Operations Center

A large supported GA operation (e.g., NetJets) will usually contract out their flight support to a flight support management company (e.g., Executive Jet Management). In terms of information exchange these companies will conduct a similar role as an AOC. Again, their primary means of communication with their fleet of aircraft is through radio communications with a non-licensed Flight Coordinator (often retired ATC or grounded pilots). They also use what amounts to their version of the dispatch release to communicate flight details to the flight crew.

2.3.2.3 General Aviation (Non-Supported)

During a non-supported GA flight the pilot is responsible for acquiring his or her own advisory information via the internet or using a vendor's electronic pay-for service. Additionally, the GA pilot may contact an AFSS, via radio or telephone (pre-flight), to file their intended flight plan. In return, the AFSS will give the pilot a flight briefing including weather conditions, any related NOTAMs, etc. The pilot can communicate with an AFSS throughout the flight.

3 AAtS Concept of Operations

AAtS is a bi-directional data link connecting aircraft and flight crews to ground operations for the purpose of exchanging advisory information in the far-term NextGen environment. AAtS will be technologically flexible, but will leverage data from a common infrastructure – SWIM; using existing NAS infrastructure including SWIM's SOA, the FTI network, and current NAS boundary protection services. The FAA will provide the appropriate SWIM data access to approved commercial vendors via the NAS boundary protection services. It is then up to the discretion of those vendors which customers receive this data, how they receive it, and how it is packaged to provide relevant information to the end-user. Aircraft systems and flight crews will also provide a down-link of relevant data to the FAA via the commercial data link. This will include both automated and manually input data used to better inform TFM, weather models, and DSTs.

The major change AAtS introduces to the exchange of advisory information is the transition from a primarily voice dependent, untimely process to a system in which on-demand access to near real-time information is the norm. Currently, advisory information is the lowest priority transmission category for exchange on safety critical aviation frequencies used by ATC for the purposes of separating aircraft.

There will be limited change required to the current operational environment (i.e., facilities and infrastructure). And although the culture of collaboration and decision making may be transformed, there will be no required procedural changes for ATC and pilot exchanges (i.e., command and control). AAtS will not be considered critical for operations; rather it will be used to support operational strategies and decisions.

The subsequent sections detail these conceptual changes further. These sections also highlight the realized benefits of a successful AAtS implementation based on the assumptions described in section 3.1.

3.1 Assumptions

Assumptions are both external and internal to the concept that guide, dictate, or control how the service is expected to operate. Internally, AAtS is contingent on the timely, successful implementation of SWIM. It is assumed that the FAA will adopt SWIM as the primary mechanism for data exchange within the NAS. The SWIM office will also establish governance for sharing this data. Other assumptions internal to the FAA include:

- AAtS will facilitate advisory data sharing only; No command and control function or trajectory negotiations
- AAtS will be implemented primarily using existing NAS infrastructure
- User availability will not be limited by the FAA to flight crews or any other specific user group

- In the instance when a flight crew has ground support (e.g., AOC) data synchronization will be required to ensure joint safety responsibility.

In order for AAtS to realize its full benefit potential, cooperation external to the FAA with vendors and end-users will be key. The FAA will not provide/design any user interfaces for displaying interpreted SWIM data. It is also assumed vendors will not restrict the FAA's access to flight crew and aircraft supplied data, via AAtS, due to cost and/or proprietary reasons. All data that is transmitted back to the FAA will have a defined location based on its intended use.

3.2 Operational Environment

The operational environment supporting AAtS will be quite different from the current operational environment described in section 2. The exchange of advisory information in NextGen's mid-term and far-term will be a collaboration of complex systems, models, and relationships. Specifically, the exchange between ground operations and flight crews will migrate from a primarily voice dependent, un-timely process to a digital, on-demand method. The following sections describe this information exchange environment. Additionally, this section explains the facilities, and infrastructure located in those facilities, that may be affected by the implementation of AAtS.

3.2.1 NextGen Information Exchange

The increase in information distribution and access for all NAS users is vital for NextGen's success. The following sections highlight what role AAtS will serve in the dissemination of flight, weather, and aeronautical information.

3.2.1.1 Flight Information – Traffic Flow Management

A major change in the NextGen mid-term will be AAtS's facilitation of robust advisory flight information. AAtS will afford flight crews the ability to obtain flight information (e.g., TMIs) digitally, on-demand, and in near real-time. This means flight crews may become aware of a TMI issued by the ATCSCC as soon as they are published. Flight crews can anticipate their next move and plan their flight accordingly based on their own set of personal preferences or company business models. This anticipation can be especially beneficial to a GA flight operating with fewer constraints than an airline. For example, the flight crew of a business jet approaching their arrival airport receives an ATCSCC advisory via AAtS. The advisory indicates a reduced airport arrival rate due to snow removal on the runway and to expect airborne holding. The indicated airborne holding will cause the flight crew's passengers to be late for their scheduled engagement. Therefore, the flight crew decides to divert to an alternate airport ensuring their passengers arrive at their engagement on time.

AAtS will also facilitate the delivery of manual and automated flight information from the flight crew and/or aircraft to the FAA. This includes individual flight performance profiles used to inform TFM models and learning-capable DSTs. See section 3.2.1.4 for more detail regarding a proposed learning-capable DST.

3.2.1.2 Weather Information

AAtS will give flight crews on-demand, near real-time access to more weather products and services than they receive now. Weather information in-flight will not be limited to on-board weather radar in the cockpit or un-timely PIREPs communicated by ATC. Pilots will have authoritative sources of weather data that will pertain to their individual route of flight, as well as the entire NAS. This will create a common NAS picture among ground operations and flight crews. Flight crews will also receive near real-time digital PIREPs informing them of key weather constraints such as turbulence or icing. Receipt of these PIREPs will be made possible by AAtS's facilitation of weather data from the flight crew to the FAA. For example, a pilot may manually input a digital report of moderate turbulence as he or she approaches an airport. This information will be immediately available to a flight crew traveling the same route. Flight Conditions Reports may also be transmitted automatically, via AAtS, assuming an aircraft is equipped with automated systems able to generate data regarding the aircraft's systems and flight conditions.

Additionally, each properly equipped aircraft will also act as a weather probe, sending automated data, via AAtS, such as near real-time flight conditions, to the FAA and other weather processors in order to better inform weather models, trajectory projections, and DSTs.

3.2.1.3 Aeronautical Information Management

The largest change in dissemination of aeronautical information will be who receives such information and the timeliness in which they receive it. Flight crews will no longer be on a "need-to-know" basis in terms of in-flight NOTAMs. AAtS will make all NOTAMs available to pilots digitally and in near real-time; especially those pertaining to the flight crews particular route of flight. For example, a NOTAM may be issued changing the status of a runway at a flight crew's destination airport to "closed". Once the flight crew is notified of this NOTAM en-route, via AAtS, rather than wait for a hold instruction from ATC, they may begin to investigate alternate airports. The timely information allows the flight crew to make a more informed decision, whether to accept holding or possibly divert.

AAtS will make near real-time status of SAA available to flight crews in-flight. The result will help improve the efficient utilization of all airspace.

3.2.1.4 A Collaborative Environment

An increase in information distribution and access in NextGen is not solely the responsibility of AAtS. Rather, AAtS is just one piece of the collaborative environment (see Figure 1). AAtS is concerned with including flight crews and their aircraft in the realm of information exchange. AAtS also is focused on exchanging advisory data only.

AAtS will not be a mechanism for command and control. Voice communications between pilots and ATC will likely continue to support command and control functions. In addition, other digitally-driven NextGen programs including Data Communications (Data Comm) and

Automatic Dependent Surveillance – Broadcast (ADS-B), for example, will be a mechanism for such functions. AAtS can complement these programs/services by providing advisory data that would otherwise be duplicated, thus reducing bandwidth and operational requirements burdening command and control programs and other NextGen initiatives. For example, the Data Comm program is currently evaluating the feasibility of graphically presenting ATC-cleared taxi routes in the cockpit. However, bandwidth restrictions facing Data Comm limit its ability to present a complete picture. AAtS could alleviate these concerns by transmitting the supplemental graphics needed to support the taxi routes (i.e., the airport surface diagram). The taxi route messages could then be overlaid, graphically onto the airport surface diagram depicting a thorough representation needed for safe taxi.

AAtS can not only be a counterpart to other NextGen programs, but can also help facilitate or enable other capabilities. For example, AAtS may be used in facilitating all of or portions (e.g., operator preferences and constraints) of the Flight Object – a NextGen project also under the CATM solution set [1]. AAtS can also be a means for data mining flight performance profiles and atmospheric conditions data in order to inform a learning-capable DST – another potential far-term NextGen project. A learning-capable DST could be a tool used to analyze historical NAS performance data against a current day's weather and traffic to provide accurate, fact-based recommendations to operations planners. Today's planning decisions at the ATCSCC are primarily based on experiences and preferences of the staff on hand. A tool such as this would incorporate automation into the decision process by identifying past days with similar weather profiles as the current day in question. The tool could then narrow the search to find days with certain operational profiles in order to establish a range of quantified performance goals with recommendations for which operations planners could choose from.

Current initiatives to provide additional weather products and services in the cockpit can be supplemented by AAtS in the far-term, assuming a robust weather data set is available through SWIM as described in section 3.1.

The goal for a collaborative environment goes beyond NextGen. A major effort is currently underway within the FAA to promote global harmonization for all future capabilities. The nature of AAtS (i.e., technologically flexible) lends itself to ensuring interoperability with international Air Navigation Service Providers.

3.2.2 NextGen Facilities/Infrastructure

The following sections describe the mandatory changes, or lack thereof, to the facilities and infrastructure housed in those locations as a result of AAtS implementation.

3.2.2.1 Flight Deck

Electronic Flight Bags are becoming the norm in the air carrier industry as well as in the GA domain; however, there is not a single solution identified for a display mechanism for AAtS data. Hardware and software interfaces for AAtS are completely up to the discretion of the vendor providing these services. However, in-flight AAtS users will have to comply with current and future FAA regulations regarding visual displays in the cockpit.

3.2.2.2 Air Traffic Control

There are no expected infrastructure changes to the ATC environment. This includes all ATC-designated areas at any FAA facilities.

3.2.2.3 Airline Operations Center/Flight Operations Center

The FAA will impose no required infrastructure changes to the operations center environment. Any AAtS information display housed in these facilities will be agreed upon by the operations center organization and the AAtS service provider.

3.2.2.4 Traffic Management Units

There are no expected infrastructure changes to the TFM environment. This includes all TMUs at any FAA facility.

3.3 Operational Procedures

AAtS is not envisioned as critical for operations; rather it is intended to support operational strategies and decisions. This means there will be limited or no official changes to procedures for ATC, pilots, dispatchers, etc. However, the way in which these NAS users conduct business and make decisions together will be altered slightly. The following sections describe how AAtS will change the advisory information exchange among NAS users in the NextGen environment.

3.3.1 Pilot – Air Traffic Control

Pilots will no longer be fully dependent on voice communications with ATC and/or AFSS specialists for obtaining advisory information pertaining to their flight. Pilots will be able to access advisory information onboard the aircraft through AAtS provided data.

This does not suggest that pilots and ATC will not communicate at all through voice; however, these transmissions will be reduced. For example, a pilot receiving information via AAtS will most likely already know the reason behind holding instructions. This will eliminate the back and forth transmissions that may have ensued between multiple controllers and the pilot. Similarly, pilots with access to AAtS information will be able to anticipate a probable re-route, for example, allowing them to investigate options based on their own preferences, thus preparing the pilot to negotiate their route change in as little as a single transmission.

In general, the transition from a delayed, voice-dominated information exchange to a digital, on-demand information exchange will reduce frequency congestion during times of major NAS impact. A reduction in human errors due to misinterpretation of advisories delivered via voice will also be apparent.

3.3.2 Pilot – Operations Center

This section is divided further to delineate between different flight operation classifications and their respective support centers, or lack thereof.

3.3.2.1 Airline Pilot – Airline Operations Center

The influx of near real-time, digital advisory information that will be available to flight crews may cause AOCs to adapt their procedures, including the role of the dispatcher. The dispatcher may be able to handle more flights because frequency congestion between flight crews and their dispatchers during major NAS impacts may be reduced. A flight crew's participation in their own flight management may also increase, sharing some of the dispatcher's load.

A dispatch release will still be the primary means by which the dispatcher communicates the details of a flight to the flight crew including aircraft type, routing, weather conditions, operating weights, etc.

3.3.2.2 General Aviation (Supported) – Flight Operations Center

In an AAtS environment, supported GA operations will still contract out their flight support to a flight support management company. Similarly to an AOC, these FOCs may see a reduced role in individual flight management because of the increased information distribution and access for flight crews. In some cases for a smaller GA operation, the need for an FOC may be eliminated altogether.

3.3.2.3 General Aviation (Non-Supported)

AAtS can play a major role in non-supported GA flight operations. TFM constraints, weather information, and aeronautical information will be available in near real-time through a common infrastructure. Access to this information can decrease the reliance a non-supported GA flight has on the AFSS for flight briefs. For example, a pilot using AAtS will be apprised of all changes in SAA status not only during pre-flight, but in-flight as well.

3.3.2.4 Traffic Managers

AAtS will not directly affect how traffic managers obtain or disseminate information. However, AAtS will indirectly impact the basis for which strategic and operational decisions are made. It is anticipated that in the far-term NextGen environment decision making at this level will become more streamlined. Traffic managers will no longer only rely on the knowledge and personal experience they have developed over time to assess a situation in the NAS. To support determining impacts, they will have additional resources in the form of DSTs. AAtS can be one of many sources that feed these automation tools with historical data that will later be used to inform models and decision making. The data feeding these tools will be sent to the FAA via the AAtS downlink as described in Figure 1.

3.4 Benefits to be Realized

AAtS will be valuable to both the FAA and external NAS users (i.e., airlines and GA). By sharing data on-demand, via a common infrastructure and in near real-time, AAtS will directly support one of the key benefits identified in the OIs aligned to the CATM solution set – *Improved Information Distribution and Access*. This improvement, in collaboration with other NextGen procedures and capabilities in the far-term, will contribute to the following NextGen benefits:

- **Improved predictability**: improved time based estimates (i.e., departure, arrival, and surface movement times) or anticipatory action based on advance knowledge of changing NAS events
- **Increased flexibility**: increased ability to evaluate options (e.g. routing, arrival airports, etc.) and make decisions based on operator preferences and constraints
- **Increased efficiency**: increased individual flight performance; increased overall NAS efficiency based on better predictability (time based and anticipatory action); or increased productivity amongst ground operations and flight crews
- **Increased access**: increased airspace access or airport access
- **Increased capacity**: increased airspace capacity or relative airport capacity (i.e., better management of demand)
- **Enhanced safety**: enhanced awareness to NAS constraints (e.g., turbulence, visibility, etc.) in flight and during taxi
- **Reduced fuel-burn and engine emissions**: reduced mileage (i.e., more efficient Four Dimensional Trajectories (4DT)) or improved engine start times and single engine taxi decisions
- **Increased user-preferred routing**: increased route selection based on individual operator optimization and preference
- **Improved operations capability analysis**: improved system performance measurement and analysis

AAtS will also contribute to a secondary set of benefits that hold a more direct link to specific AAtS enhancements. Referenced in the following sections, these include:

- **Increased common SA**: increased awareness for flight crews regarding changing NAS constraints and/or impacts to their flight; increased awareness of larger NAS picture (e.g. surface operations); increased common awareness between flight crews and ground operations
- **More informed decision making**: better realized conclusions based on access to the most relevant information in near real-time
- **Enhanced strategic planning**: enhanced flight crew and/or ground operations ability to plan their flight(s), minimizing the reactionary changes during flight

- **Reduced voice communications**: less reliance on voice transmissions for advisory information between flight crew and ground operations due to the increased access to digital information

4 Operational Scenarios

The following scenarios illustrate how the AAtS concept, described in section 3, can satisfy an operational need. Presented, are nine event-driven scenarios each focusing on a single, unique incident in the NAS. Table 1 gives a brief summary of each scenario.

Each of the operational scenarios assumes the mid-term or far-term NextGen environment as described in this document. Assumptions detailed in section 3.1 also apply to all scenarios. Any assumptions that are specific to a particular scenario will be explained in the *Scenario Introduction* section. Finally, the term, "AAtS", is sometimes used in these scenarios as a generic term to describe a service, interface or tool designed by a vendor for accessing information via the AAtS data link.

The scenarios will be presented in the following format:

- Scenario Name
- Scenario Objective
- Scenario Introduction: All supplemental information that is required for the reader to understand the scenario (e.g., airspace conditions, phase of flight, additional assumptions, etc.)
- Operational Scenario: Description of the activities that take place in the event focusing on the practicality of AAtS
- Benefits: Identification of both NextGen benefits and secondary benefits that AAtS will contribute to

The guidelines set forth in *Action Plan 5: Validation and Verification Strategies: Operational Concept Validation Strategy Document – a FAA/EUROCONTROL Memorandum of Co-operation* [6] were used to drive the development of these scenarios. The *Integration of Unmanned Aircraft Systems into the National Airspace System Concept of Operations V2.0* [7] was also referenced as an example template.

Table 1 Summary of Operational Scenarios

Scenario Name	Scenario Objective	NextGen Benefits
Trajectory Information Exchange	Demonstrates how AAtS can provide flight crews the ability to plan in-flight trajectory options. It also demonstrates how AAtS can allow flight crews to update surface movement data to inform the 4DT and minimize the impact to surface operations (in NextGen, the 4DT extends from gate-to-gate).	Improved Information Distribution and Access; Improved Predictability; Increased Flexibility; Reduced Fuel-burn and Engine Emissions; Increased User-preferred Routing
Weather Modeling	Demonstrates how AAtS can transmit near real-time data on atmospheric conditions to improve weather models used by the FAA the FAA which are critical to informing DSTs and planning NAS system operations.	Improved Information Distribution and Access; Improved Predictability; Increased Efficiency; Reduced Fuel-burn and Engine Emissions
Automated Flight Service Station	Demonstrates how AAtS can support the future AFSS and the GA flight crews utilizing it by transitioning from a voice-dependent system to a primarily automated and digital exchange [8].	Improved Information Distribution and Access; Increased Efficiency; Enhanced Safety
Special Activity Airspace	Demonstrates how AAtS can provide flight crews near real-time awareness in flight of SAA status which creates a more flexible, accessible NAS and allows aircraft operators to make tactical changes to their flight plan.	Improved Information Distribution and Access; Increased Flexibility; Increased Efficiency; Increased Access; Increased Capacity; Reduced Fuel-burn and Engine Emissions; Increased User-preferred Routing
Automated Flight Conditions Report	Demonstrates how AAtS can provide flight crews the means to automatically transmit, receive and review near real-time flight conditions reports. This will ensure flight crews access to this type of information and minimize the impact to ATC frequencies.	Improved Information Distribution and Access; Enhanced Safety

Scenario Name	Scenario Objective	NextGen Benefits
Airport Diversion Planning	Demonstrates how AAtS can provide GA flight crews with near real-time access to relevant NOTAMs allowing flight crews to have a complete picture of the event and its impact to their flight in order to better inform their decision making.	Improved Information Distribution and Access; Increased Flexibility; Increased Access; Increased Capacity
Surface Management with Trajectory Based Operations	Demonstrate how AAtS allows the flight crew to efficiently exchange information with the full range of NAS entities (e.g., De-ice Control) while providing support to surface management by incorporating future Trajectory Based Operations.	Improved Information Distribution and Access; Improved Predictability; Enhanced Safety; Reduced Fuel-burn and Engine Emissions
En-route Strategic Planning	Demonstrates how AAtS can provide flight crews with near real-time access to relevant NOTAMs and ATCSCC advisories giving them the opportunity to plan their flight, rather than reacting to unplanned events.	Improved Information Distribution and Access; Improved Predictability
Learning-Capable DST	Demonstrates how AAtS can provide flight crews and the aircraft a means to transmit near real-time information that could be used to help model an accurate picture of the events of a particular day in the NAS, which can ultimately be used to inform a learning-capable DST.	Improved Information Distribution and Access; Improved Predictability; Improved Efficiency; Improved Operations Capability Analysis

4.1 Operational Scenario 1 Objective – Trajectory Information Exchange

This scenario demonstrates how AAtS can provide flight crews the ability to plan in-flight trajectory options. It also demonstrates how AAtS can allow flight crews to update surface movement data to inform the 4DT and minimize the impact to surface operations (in NextGen, the 4DT extends from gate-to-gate).

4.1.1 Scenario Introduction

A business jet (N381) is scheduled to depart SFO at 1400 UTC destined for TEB with an Estimated Time of Arrival (ETA) of 1830 UTC. Once on the ground at TEB, the flight crew has a turn-around time of 45 minutes, giving them an estimated time of departure out of TEB of 1915 UTC. This flight is not supported by an operations center. AAtS is configured to notify the flight crew of information and NAS events that may directly impact the operation of their flight.

The original route filed is SFO LIN J84 DTA EKR DVV AKO HCT J60 JOT ELX SVM J70 LVZ LVZ4 TEB. The weather is currently Visual Meteorological Conditions (VMC), but the forecast calls for thunderstorms to develop in ZAU, ZOB, and ZID airspace.

4.1.2 Operational Scenario

N381 departs SFO. At 1500 UTC, over DTA (Delta, UT) VOR, the flight crew receives a notification through AAtS of an FCA from GRB (Green Bay, WI) VOR to VHP (Indianapolis, IN) VOR, in order to manage traffic levels due to a reduced capacity from developing convective weather. The notification is an ATCSCC advisory identifying the reduced capacity through the constrained area. The advisory also indicates traffic into select airports (including TEB) will be re-routed via one of the two indicated alternate routes. The flight crew investigates the two route options; the northern route – RAP J158 ABR CESNA SSM YCF TULEG HNK V167 WEARD V489 COATE TEB; and the southern route – PUB GCK ICT SGF J98 FAM J78 IIU J526 BKW J42 GVE JAIKE3 TEB. The flight crew submits, via AAtS, both options to an automated route evaluation tool. The tool evaluates the alternate routes for flight time, distance, forecasted weather, etc. based on criteria set forth by the aircraft operator. The automation then returns a message, via AAtS, indicating the route to the south of the FCA is the most desirable; PUB GCK ICT SGF J98 FAM J78 IIU J526 BKW J42 GVE JAIKE3 TEB.

At 1505 UTC, the captain contacts ATC and requests a route change to TEB via PUB GCK ICT SGF J98 FAM J78 IIU J526 BKW J42 GVE JAIKE3. ATC clears N381 and the aircraft continues to TEB. N381 lands at 1850 UTC. The new route added approximately 116 nautical miles and 20 minutes of flight time to N381's original flight plan.

At the time of arrival, a Departure Management Program (DMP) is in place at TEB due to reduced departure capacity from the previously mentioned convective weather. The current P-time[9] for N381's next departure leg is 1910 UTC. Due to the delay, the Captain inputs, using AAtS, a new Earliest Off Block Time (EOBT) of 1930 UTC in order to inform the DMP. The DMP re-allocates N381's Target Movement Area Entry Time (TMAT) and disseminates to ATC, the Fixed Based Operator (FBO), airport operators, and select flight operators. The FBO relays N381's new TMAT of 1940 UTC to the Captain. N381 begins taxi to the target movement area at 1930 UTC. At 1940 UTC, ATC clears N381 to taxi to the runway. N381departs TEB at 1945 UTC, 30 minutes behind schedule.

4.1.3 Benefits

NextGen benefits:

- **Improved information distribution and access** – The flight crew had access to TFM information (i.e., FCA) digitally, and in near real-time. Without AAtS, the non-supported

[9] Proposed departure time or ready time; scheduled by the aircraft operator as the earliest possible time he or she is ready for pushback and/or departure.

flight crew would not have received the ATCSCC advisory and been unaware of the FCA until it was realized by airborne holding and/or a re-route.

- **Improved predictability –** The flight crew was able to inform the DMP of their updated EOBT, improving the predictability of their departure plans.
- **Increased flexibility** – The flight crew was able to evaluate multiple trajectory options, based on their own operational criteria. ATC is not responsible for evaluating individual flight efficiency; rather they are concerned with balancing system capacity and demand.
- **Increased efficiency** – Because N381 was able to amend their EOBT, their spot in the departure sequence would not be wasted because of their inability to comply with original TMAT (i.e., other aircraft would be able to move up in sequence)
- **Reduced fuel-burn and engine emissions –** Although the flight crew added 116 nautical miles to their flight, the south route was more efficient than the possibility of being routed north or continuing on their given trajectory and accepting re-routing down range.
- **Increased user-preferred routing –** The user (flight crew) chose a new route based on their own criteria. Without AAtS, the flight crew would be assigned routing at the discretion of ATC.

Secondary benefits aligned with AAtS:

- **Increased common SA** – The flight crew had access to the FCA advisory in near real-time, which would normally only be available to ground operations.
- **Enhanced strategic planning** – The flight crew is given information informing them of the constraint (i.e., FCA), the impact, and the alternatives to mitigate the impact. This allows the flight crew to plan their route based on the option that best fits their operational criteria. Without AAtS, the flight crew would have been forced to react to ATC instruction.
- **Reduced voice communications** – The flight crew digitally submitted their new EOBT for use in the DMP. The information provided in the advisory gave the flight crew a complete picture of the impact to their flight which eliminated the need for the back and forth communication with ATC.

4.2 Operational Scenario 2 Objective – Weather Modeling

This scenario demonstrates how AAtS can transmit near real-time data on atmospheric conditions to improve weather models used by the FAA and industry which are critical to informing DSTs and planning NAS system operations.

4.2.1 Scenario Introduction

An Airbus 320 (A320) is scheduled to depart EWR at 1400 UTC destined for SFO with an ETA of 1940 UTC. This flight is supported by an operations center.

A Boeing 757 (B757) is en-route traveling westbound from EWR to SFO at FL320. The B757 departed at 1200 UTC. This flight is also supported by an operations center. The B757 is equipped with automated systems able to generate data regarding the aircraft's systems and flight conditions. The originally filed flight plans for both the A320 and the b757 are identical in terms of their 4DT.

At 0900 UTC atmospheric conditions data was gathered by weather balloon launches at 92 locations across the United States in order to inform weather models used by the FAA. The models predict upper wind from 270 at 125 knots at FL320 along the A320 and B757s 4DT.

4.2.2 Operational Scenario

The B757 is traveling west bound over ROD (Rosewood, OH) VOR at 1300 UTC. The Captain refers to the Flight Management System (FMS), which displays an updated ETA of 1715 UTC based on a reduction in upper winds.

Meanwhile, National Oceanic and Atmospheric Administration's (NOAA) weather models are continuously being updated based on atmospheric conditions being transmitted via hundreds of AAtS-equipped aircraft, including the B757. At 1300 UTC the models now forecast upper winds from 270 to be 60 knots at FL320. The dispatcher supporting the A320, having access to the NOAA models, updates the flight plans for the aircraft he or she is responsible for. The A320 now has an ETA of 1910 UTC. The A320 departs EWR at 1400 UTC. The A320's AOC works with airport operations while the flight is en-route to adjust gate availability allowing the A320 to meet its ETA of 1910 UTC. The A320 touches down at SFO at approximately 1910 UTC and proceeds to the newly assigned gate.

4.2.3 Benefits

NextGen benefits:

- **Improved information distribution and access** – Hundreds of aircraft continuously transmitted near real-time atmospheric conditions, via AAtS, for use by the FAA that are normally forecast by just a twice-a-day weather balloon launch.
- **Improved predictability** – The continuously updated forecast provided a better ETA for the A320 in pre-flight planning.
- **Increased efficiency** – This scenario focuses on the benefit to one flight; the A320. However, better predictability for a fleet of aircraft and/or all aircraft in the NAS could improve the entire systems' efficiency.
- **Reduced fuel-burn and engine emissions** – The dispatcher supporting the A320 updates all the flight plans he is responsible for. This could include adjusting 4DTs based on improved weather predictions (i.e., more favorable upper winds).

Secondary benefits aligned with AAtS:

- **Enhanced strategic planning** – The improved weather models prompted the dispatcher to strategically plan each of his flights. This included planning gate availability for the A320, but could also include 4DT changes for the rest of his flights.

4.3 Operational Scenario 3 Objective – Automated Flight Service Station

This scenario demonstrates how AAtS can support the future AFSS and the GA flight crews utilizing it by transitioning from a voice-dependent system to a primarily automated and digital exchange [8].

4.3.1 Scenario Introduction

The pilot of a Cessna 210 (C210) is planning to depart HEF (Manassas, VA) at 1500 UTC destined for RIC (Richmond, VA) with an ETA of 1545 UTC. This flight is not supported by an operations center. The C210 is Instrument Flight Rules (IFR) equipped and the pilot is IFR rated. The pilot is utilizing AAtS data via an application that has been developed by an AAtS vendor who is also the current AFSS provider for the FAA[10].

4.3.2 Operational Scenario

The pilot begins pre-flight checks at 1400 UTC (approximately one hour prior to the planned departure time). Upon completion of pre-flight checks, the pilot uses AAtS to check for any relevant NOTAMs impacting the flight at HEF, RIC, and along the planned route. The pilot obtains a NOTAM indicating restricted areas R6608A/B and C (south of HEF) will be in use from 1200 UTC to 1700 UTC and concludes he or she will need to fly around the restricted areas. The pilot also uses AAtS to check the weather forecast impacting his flight which indicates VMC exist.

The pilot then submits, via AAtS, a Visual Flight Rules (VFR) flight plan (HEF to RIC) to the AFSS. At 1455 UTC, the pilot contacts HEF ground control and requests taxi to the active runway. The C210 is cleared to taxi. Local control then clears the C210 for take-off and once airborne the pilot contacts Potomac TRACON (PCT) for VFR flight following. PCT acknowledges the C210 and the pilot activates his VFR flight plan via AAtS. While en-route, just south of the restricted areas, the C210 enters an area of light chop at 2500 MSL. Using AAtS, the pilot transmits a digital PIREP to the AFSS identifying the severity of turbulence, location, altitude, and aircraft type.

As the C210 approaches the Richmond area, the pilot uses AAtS to review the current, digital ATIS in order to plan the arrival into RIC. PCT transfers aircraft identification to RIC tower. PCT then advises the C210 to contact local control for landing instructions. The pilot contacts RIC tower with the current ATIS information and is cleared to land. Upon landing, the C210 clears the active runway and the pilot contacts ground control for taxi instruction to the FBO. Once parked at the FBO the pilot closes his VFR flight plan via AAtS.

[10] This is a far-term NextGen scenario and it is assumed during a re-compete, the winning AFSS provider agreed to deliver some services through AAtS applications as part of its bid to execute the AFSS contract.

4.3.3 Benefits

NextGen benefits:

- **Improved information distribution and access** – The Pilot had access to weather information, NOTAMs, and the ATIS digitally and near real-time. Currently, the previous information items are all dependent on voice communication or frequency monitoring. The pilot also transmitted a digital PIREP for other pilots use.
- **Increased efficiency** – The pilot's ability to activate and close VFR flight plans digitally and in near real-time is more efficient than the current voice-dependent system.
- **Enhanced safety** – The pilot's ability to transmit PIREPs in near real-time enhances the safety of other airspace users.

Secondary benefits aligned with AAtS:

- **More informed decision making** – The weather information received through AAtS allowed the pilot to make an informed decision to file VFR, rather than IFR.
- **Reduced voice communications** – Little to no voice communication was needed by the pilot to receive and transmit advisory information. The digital PIREP submitted through AAtS allows the turbulence information to be re-broadcast quickly and distributed widely.

4.4 Operational Scenario 4 Objective – Special Activity Airspace

This scenario demonstrates how AAtS can provide flight crews near real-time awareness in flight of SAA status which creates a more flexible, accessible NAS and allows aircraft operators to make tactical changes to their flight plan.

4.4.1 Scenario Introduction

A business jet (N816) is scheduled to depart LGA at 1320 UTC destined for MIA with an ETA of 1540 UTC. This flight is supported by an operations center. The optimum, over-water and originally filed route of flight is LGA WHITE J209 SBY KEMPR DIW NDB AR22 JORAY HILEY4 MIA. AAtS is configured to notify the flight crew of information and NAS events that may directly impact the operation of their flight.

4.4.2 Operational Scenario

The flight crew checks in at 1220 UTC (approximately one hour prior to the planned departure time). The flight crew is informed by their FOC that the filed route has been changed to LGA WHITE J209 SBY J79 KATZN ISO J121 CHS J79 OMN HILEY4 MIA due to closed airspace off the coast of Florida for planned military training operations. N816 departs LGA on the new route at 1320 UTC. During cruise, at 1405 UTC, just north of the ORF (Norfolk, VA) VOR, the pilot is notified via AAtS to a change in status of the airspace that impacted the original route of flight. Due to a cancellation in the training operation, the previously closed airspace is now open and available for use. The pilot contacts ATC and requests a new route to MIA via direct

KEMPR DIW NDB AR22 JORAY HILEY MIA. ATC clears the flight as requested. N816 continues to MIA and lands at 1540 UTC. This alternate route saved N816 approximately 54 nautical miles and 6 minutes of flight time.

4.4.3 Benefits

NextGen benefits:

- **Improved information distribution and access** – The flight crew was able to access SAA status information digitally, and in near real-time without relying on their FOC.
- **Increased flexibility** – The flight crew was able to choose the route that best fit their need based on the changing SAA status.
- **Increased efficiency** – The flight crew was able to fly the over-water route because of their access to changing SAA status. Because the over-water route typically has less traffic and restrictions than the land route, the flight was able to fly at its optimum flight performance profile.
- **Increased access** – The flight crew was aware of access to airspace that was previously closed.
- **Increased capacity** – The flight crew was able to fly the over-water route because of their access to changing SAA status. Because the land route typically has more traffic and restrictions than the over-water route, the change in route increased the capacity of the land route, while balancing the demand of the combined routes.
- **Reduced fuel-burn and engine emissions** – The route change saved 54 nautical miles.
- **Increased user-preferred routing** – The flight crew was able to fly the optimal and originally filed route.

Secondary benefits aligned with AAtS:

- **Increased common SA –** The flight crew had near real-time awareness to changing SAA status normally reserved for ground operations.
- **More informed decision making** – The flight crew was able to make a tactical decision to change their route of flight based on changing SAA status.

4.5 Operational Scenario 5 Objective – Automated Flight Conditions Report

This scenario demonstrates how AAtS can provide flight crews the means to automatically transmit, receive and review near real-time flight conditions reports. This will ensure flight crews access to this type of information and minimize the impact to ATC frequencies.

4.5.1 Scenario Introduction

A Boeing 767 (B767) is en-route traveling eastbound to EWR at 1400 UTC with an ETA of 1545 UTC. This flight is supported by an operations center. The B767 is equipped with automated systems able to generate data regarding the aircraft's systems and flight conditions. A

Cessna 650 (C650) is traveling approximately 30 minutes behind the B767 on the same route to EWR with an ETA of 1615 UTC. This flight is not supported by an operations center.

Both flight crews configure AAtS to notify them of information and NAS events that may directly impact the operation of their flight.

4.5.2 Operational Scenario

At 1400 UTC, the B767 enters an area of turbulence at FL310 over TVC (Traverse City, MI) VOR. The B767 automatically generates a flight conditions report which AAtS then transmits to the FAA regarding current atmospheric conditions. The transmission reports light to moderate turbulence based on the B767s aircraft type.

At 1405 UTC, the flight crew of the C650 is notified, via AAtS, of an automated flight conditions report. The transmission they receive is reporting moderate to severe turbulence at FL310 over TVC VOR[11].

At 1410 UTC, the C650 flight crew uses AAtS to review all digital flight conditions reports and PIREPs for the TVC area, which indicate a smoother ride at FL350. The flight crew then contacts ATC and requests FL350 due to indicated turbulence at lower altitudes. ATC clears the C650 for the altitude change.

4.5.3 Benefits

NextGen benefits:

- **Improved information distribution and access** – The flight crew of the C650 had access to a tailored, automated flight conditions report from the B767 as well as reports and PIREPs from other aircraft and flight crews digitally, and in near real-time. Today the flight crew is dependent upon voice communications with ATC, other pilots, or their own operations support.
- **Enhanced safety –** With AAtS, the flight crew of the C650 was aware of turbulence approximately 25 minutes before entering the identified airspace.

Secondary benefits aligned with AAtS:

- **Increased common SA –** The C650, the B767, and ATC were all aware of the atmospheric conditions around TVC at FL310 in near real-time.
- **Reduced voice communications** – A flight conditions report from the B767 was transmitted and tailored to the C650 without impacting ATC frequencies. The flight

[11] This happens to be the same flight conditions report the B767 generated, however NNEW products digested this report and tailored it to the receiving aircraft, based on its aircraft type. For safety purposes, a flight conditions report in the future may include both the actual transmission from the reporting aircraft as well as the NNEW automated interpretation.

crew's ability to review additional reports and determine the best altitude at which to fly eliminated the back-and-forth exchange with ATC.

4.6 Operational Scenario 6 Objective – Airport Diversion Planning

This scenario demonstrates how AAtS can provide GA flight crews with near real-time access to relevant NOTAMs allowing flight crews to have a complete picture of the event and its impact to their flight in order to better inform their decision making.

4.6.1 Scenario Introduction

A business jet (N193) is scheduled to depart IND at 2200 UTC destined for TEB with an ETA of 0030 UTC (after sunset). This flight is not supported by an operations center. The passengers on board have a scheduled engagement starting at 0130 UTC. AAtS is configured to notify the flight crew of information and NAS events that may directly impact the operation of their flight.

4.6.2 Operational Scenario

N193 departs IND at 2200 UTC. At 2330 UTC, as the aircraft approaches JHW (Jamestown, NY) VOR in ZOB airspace, the flight crew is notified, via AAtS, of a NOTAM impacting their flight. The NOTAM states all runway lights at TEB are experiencing an outage and the runways are closed. This prompts the flight crew to investigate the outage. They check the New York area status board, accessed through AAtS, and they discover the New York Port Authority expects two hours to remedy the situation and re-open the runways. The Captain advises the passengers they could be experiencing airborne holding for up to an hour or they could divert to an alternate airport in the New York area. The flight crew uses AAtS to identify HPN (Westchester, NY) as the best alternate airport in the immediate area based on runway length, current airport arrival rate, and driving distance to the passenger's engagement. Based on the passenger's engagement at 0130 UTC, the Captain decides diverting to HPN is the best option. The flight crew contacts ATC and requests to change their destination airport to HPN. ATC clears the flight to HPN and they continue with no delay. N193 lands at 0030 UTC. The passengers arrive at their scheduled engagement on-time.

4.6.3 Benefits

NextGen benefits:

- **Improved information distribution and access** – The flight crew had access to NOTAMs digitally, and in near real-time.
- **Increased flexibility** – Access to the near real-time NOTAM prompted the flight crew to use AAtS to investigate multiple solutions; accepting airborne holding or divert to another airport.
- **Increased access –** The flight crew used AAtS to further investigate the outage and find alternative solutions; one of which was available access to an alternate airport (i.e., HPN).

- **Increased capacity** – Due to N193's diversion, capacity into TEB was increased. Airspace capacity is also increased where N193 would have been holding.

Secondary benefits aligned with AAtS:

- **Increased common SA** – The flight crew was aware of changing NAS equipment status in near real-time allowing for common understanding of why they would be instructed to hold.
- **More informed decision making** – The flight crew was able to choose the best option (divert to TEB) for their passenger's needs.
- **Reduced voice communications** – Having access to the digital NOTAM and additional information on TEB status (i.e, New York area status board) eliminated the need for the back-and-forth communication with ATC regarding TEB status and what the flight crews impact would have been.

4.7 Operational Scenario 7 Objective – Surface Management with Trajectory Based Operations

This scenario will demonstrate how AAtS allows the flight crew to efficiently exchange information with the full range of NAS entities (e.g., De-ice Control) while providing support to surface management by incorporating future Trajectory Based Operations[12].

4.7.1 Scenario Introduction

An air cargo jet (ACG355) is scheduled to depart IAD northbound at 0100 UTC. This flight is supported by an operations center. IAD is experiencing moderate to heavy snow conditions with visibility less than a mile. Aircraft de-icing is in effect and an automated de-icing status queue, accessed via AAtS, is in use that allows override and write-access to De-ice Control[13] and read-access to AOCs, FOCs, ATC, flight crews, etc. A DMP is currently in effect at IAD in order to manage surface operations and ACG355's Initial Off-Block Time (IOBT) is 0050 UTC. AAtS is configured to notify the flight crew of information and NAS events that may directly impact the operation of their flight.

4.7.2 Operational Scenario

During pre-flight, the flight crew determines de-icing of the aircraft is required. At 0030 UTC, the flight crew submits to De-ice Control a request, via AAtS, to be scheduled for de-icing. Based on current surface capacity and demand and ACG355s preferences (i.e., IOBT), automation determines a de-ice slot time of 0230 UTC; a two hour wait to enter the de-ice pad. At 0035 UTC, De-ice Control transmits through AAtS a simultaneous message to the ACG355

[12] The far-term concept of an ATM system in which equipped aircraft operating in and managed by the system are represented by a 4DT identifier. A 4DT flight plan includes a series of points from departure to arrival representing the aircraft's path in four dimensions: latitude, longitude, altitude, and time.

[13] This position is only activated during de-ice events and has complete authority over the de-ice status queue and program as a whole. Position may be managed by either the airport or the largest operator at that airport.

flight crew and their FOC informing them of their proposed de-ice slot time and asking for receipt and concurrence. At 0036 UTC, ACG355 confirms receipt and concurrence with an AAtS transmitted message back to De-ice Control. At 0040 UTC, the FOC confirms receipt and concurrence with an AAtS transmitted message back to De-ice Control. Upon both parties confirmation[14], the automation immediately updates the de-ice queue to include ACG355.

At 0041 UTC, the Captain of the ACG355 opens the de-ice status queue on the AAtS application and confirms the flight is twelfth in the queue with a de-ice slot time of 0230 UTC. This prompts the Captain to submit a new EOBT through AAtS of 0215 UTC in order to inform the DMP (at this time the 4DT assigned to the aircraft is also updated based on the new EOBT)[15].

Between 0041 UTC and 0130 UTC the de-ice queue is updated significantly due to faster than anticipated de-ice operations. At 0130 UTC, the flight crew receives an alert via AAtS. The alert is from De-ice Control offering a new de-ice slot time and requesting confirmation of receipt and concurrence. Again, this message was also simultaneously sent to the FOC. The ACG355 and their FOC confirm receipt and concurrence with two separate messages back to De-ice Control. Upon receipt, the automation then updates the de-ice status queue. ACG355 is now fifth in line with a de-ice slot time of 0205 UTC.

The Captain uses AAtS to once again update ACG355's EOBT, submitting a time of 0150 UTC to inform the DMP (Again, the 4DT assigned to the aircraft is also updated based on the new EOBT).

At 0150 UTC, the First Officer (FO) contacts ramp control and requests pushback. ACG355 is given approval to pushback and instructed to contract ground control for taxi instructions. The Captain initiates pushback and starts the engines. This prompts the FO to submit an Actual Off-Block Time (AOBT)[16] through AAtS of 0150 UTC (the 4DT assigned to the aircraft is confirmed based on the AOBT).

Immediately following, the FO contacts ground control and requests taxi clearance to the de-icing pad. At 0155 UTC, ACG355 is cleared by ground control to taxi to the de-icing pad. Due to poor out-the-window visibility at the airport, the Captain consults an airport surface diagram[17], via AAtS, to verify their taxi route. At 0200 UTC, ACG355 taxis to the de-icing pad. ACG355 reaches the de-icing pad at 0205 UTC (precisely meeting their de-ice slot time). De-icing takes twenty minutes and is complete at 0225 UTC.

[14] Flights that are not supported by an operations center will only receive one message and require one receipt and confirmation message.
[15] It is assumed that the 4DT also takes into account anomalies throughout the scenario; such as de-icing in this example.
[16] Different operators may have different means of tracking surface movement data (e.g., AOBT) to include both manually and automated.
[17] See section 3.2.1.4 for more details regarding a proposed airport surface diagram.

Upon completion of de-icing, the flight crew is given taxi instructions to proceed to runway 30. The aircraft reaches runway 30, is cleared for takeoff, and departs at 0235 UTC. The FO submits through AAtS an Actual Takeoff Time (ATOT) of 0235 UTC (the 4DT assigned to the aircraft is updated based on the ATOT).

4.7.3 Benefits

NextGen benefits:

- **Improved information distribution and access** –The flight crew had access to current airport operations activity (i.e., de-icing activity) digitally, and in near real-time. Ground operations had greater access to aircraft operator's movement, intent, and availability informing 4DTs.
- **Improved predictability** – The surface movement data submitted via AAtS is providing greater predictability for taxi and departure times.
- **Enhanced safety** – The surface display utilized by the flight crew provided an extra layer of safety when taxiing during times of poor out-the-window visuals. Today, flight crews are completely dependent on visual cues out-the-window.
- **Reduced fuel-burn and engine emissions –** Better access to de-icing activity and taxi estimations allowed flight crews to be more efficient when starting engines and initiating taxi

Secondary benefits aligned with AAtS:

- **Increased common SA** – The airport surface display gave the flight crew more SA regarding the airport surface and traffic movements. Access to the de-ice status queue in near real-time gave the flight crew awareness of their position and progress in relation to the rest of the aircraft at IAD.
- **Reduced voice communications** – Access to the de-ice status queue provided flight crews with information in which they would otherwise be receiving through voice communications with their operation center, airport operations, and/or ATC.

4.8 Operational Scenario 8 Objective – En-route Strategic Planning

This scenario demonstrates how AAtS can provide flight crews with near real-time access to relevant NOTAMs and ATCSCC advisories giving them the opportunity to plan their flight, rather than reacting to unplanned events.

4.8.1 Scenario Introduction

An air carrier jet (ACR385) is en-route traveling eastbound to EWR at 1700 UTC with an ETA of 1800 UTC. This flight is supported by an operations center. AAtS is configured to notify the flight crew of information and NAS events that may directly impact the operation of their flight.

4.8.2 Operational Scenario

At 1700 UTC, over YNG (Youngstown, OH) VOR, the flight crew is notified, via AAtS, of a NOTAM that runway 4R/22L at EWR is closed. This prompts the flight crew to contact their AOC concerning the runway closure. They are advised that a B737 blew a main landing gear tire on runway 4R. At this time it is unknown how long the runway will be closed. Based on fuel requirements, the dispatcher advises the flight crew they can accept holding for up to 45 minutes if needed.

At 1710 UTC, the flight crew is notified of an ATCSCC advisory, via AAtS, stating that airborne holding of 15 to 20 minutes is expected with maximum delays of 40 minutes. Based on fuel requirements and the ATCSCC advisory, the flight crew consults their dispatcher and together they decide the best course of action is to accept the expected holding.

At 1715 UTC, ACR385 is cleared to SLATE RUN and issued airborne holding with an expect further clearance of 1740 UTC, well within the flight's holding limit. At 1740 UTC, ACR385 is cleared out of holding and continues to EWR without further delays. ACR385 lands at EWR at 1820 UTC.

4.8.3 Benefits

NextGen benefits:

- **Improved information distribution and access** – The flight crew had access to NOTAMs and advisories digitally, and in near real-time. The flight crew did not rely on their AOC for retrieving this information. Fifteen minutes between the time of the issued NOTAM and the holding instructions may or may not have been enough time for the AOC to retrieve and relay the relevant information.
- **Improved predictability** – The flight crew had advance knowledge of expected ATC actions due to the events at EWR airport.

Secondary benefits aligned with AAtS:

- **Increased common SA** – The flight crew was aware of the events at EWR and to the potential impacts to their flight.
- **Enhanced strategic planning** – Because of the advance information, the flight crew was given the opportunity to plan, along with their AOC, the best course of action based on a best case and worst case scenario. Ultimately, the decision to accept holding for 20 minutes fit their needs.
- **Reduced voice communications** – Because on the advance information and the collaboration with their AOC, the flight crew's communication with ATC was reduced upon receipt of airborne holding. There was no need for clarification or negotiation.

4.9 Operational Scenario 9 Objective – Learning-Capable Decision Support Tool

This scenario demonstrates how AAtS can provide flight crews and the aircraft a means to transmit near real-time information that could be used to help model an accurate picture of the events of a particular day in the NAS, which can ultimately be used to inform a learning-capable DST.

4.9.1 Scenario Introduction

An Airbus 320 (A320) is en-route traveling eastbound through ZAU airspace at 1430 UTC destined for LGA with an ETA of 1530 UTC. This flight is supported by an operations center. The A320 is part of an air carrier fleet with over 700 aircraft; 300 of which are airborne during the A320s flight. The entire fleet is equipped with automated systems able to generate data regarding the aircraft's systems and flight conditions. AAtS is configured on the A320 to notify the flight crew of information and NAS events that may directly impact the operation of their flight. The weather forecast is calling for thunderstorms along the east coast affecting airports and traffic in ZDC, ZNY, and ZBW airspace.

The year is 2023 and AAtS has been implemented for 5 years. For the past 5 years, AAtS-equipped aircraft have been transmitting, through AAtS, actual atmospheric conditions to a data repository used to inform a learning-capable DST. These aircraft have also been transmitting automated and/or manual flight performance profiles (i.e., planned profile versus actual profile) to the same data repository.

4.9.2 Operational Scenario

At 1400 UTC, a traffic manager at the ATCSCC is using the learning-capable DST to search for historical instances of days with similar weather forecasts to help manage capacity and demand at the New York area airports. The DST finds many historical days that fit the criteria and ultimately offers the traffic manager several solutions on how to handle arrivals into the New York area airports, based on a range of NAS performance goals. Several TMIs will be issued resulting in potential airborne holdings, re-routings, and updated navigational fix crossing times.

Meanwhile, the A320's AOC is using the same DST (at the same time) in order to anticipate the FAAs forthcoming actions. The AOC personnel also conclude that several TMIs will be issued resulting in potential airborne holdings, re-routes, and updated fix crossing times. This information is disseminated throughout the AOC to all dispatchers.

At 1420 UTC, a dispatcher contacts the flight crew of the A320 and informs them of a probable update to their fix cross time at ETG (Keating, PA) VOR due to thunderstorms affecting route availability into LGA.

At 1425 UTC, the flight crew of the A320, along with their dispatcher, makes the decision to slow their airspeed slightly in anticipation of an updated fix crossing time[18]. At 1427 UTC, the

[18] The flight crew would normally advise ATC of a reduction in speed as needed, per current operational procedures.

Captain informs the passengers of a possible delay into LGA. At 1430 UTC, the flight crew is notified of an advisory, via AAtS, that a GS has been issued at LGA. The advisory also states all arriving aircraft into LGA can expect revised fix crossing times. At 1435 UTC, the flight crew receives a new fix crossing time for ETG of 1525 UTC via Data Comm. At 1440 UTC the flight crew contacts their dispatcher to evaluate the given time and discuss possible options. Together, they agree to further adjust their airspeed and the flight crew accepts the fix crossing time. The FMS on-board the A320 automatically adjusts the aircraft's airspeed in order to meet the given time. The A320 continues to LGA and the Captain informs the passengers they will be arriving about 30 minutes late. The A320 lands at 1600 UTC.

The flight performance profile and atmospheric conditions data for the A320 (and the rest of its fleet) are automatically transmitted, via AAtS, to the FAA into a database that will inform the same DST that helped traffic managers make decisions today.

4.9.3 Benefits

NextGen benefits:

- **Improved information distribution and access** – The flight crew had access to TFM information (i.e., GS) digitally, and in near real-time. Flight performance profile and atmospheric conditions data was shared via AAtS and used to inform the learning-capable DST.
- **Improved predictability** – The data informing the learning-capable DST created a predictable response from TFM and allowed the AOC to take anticipatory action.
- **Increased efficiency** – In the year 2023, the predictable response from the FAA triggered a similarly predictable reaction from the A320 and its fleet, further increasing the efficiency of the NAS
- **Improved operations capability analysis** – The data, transmitted via AAtS, feeding the learning-capable DST will allow the FAA to more accurately measure system performance. This will help the FAA manage the NAS on a daily basis using a range of performance goals, rather than managing to differing human experiences and perspectives.

Secondary benefits associated with AAtS:

- **Increased common SA** – TFM, the AOC, and the flight crew of the A320 were all aware of the same pending GS and how it would affect flight operations in near real-time.
- **Enhanced strategic planning –** The flight crew and the AOC worked together to come up with a strategy that minimized impacts to their flight well in advance of receiving direction from ATC.

5 Summary of Impacts

This section summarizes anticipated impacts implementing AAtS will have on current operations that affect key FAA performance areas. Key performance areas include organization and staffing, cost effectiveness, environmental impact, safety, security, capacity, access and equity, efficiency, and global interoperability. This section will also describe the impacts AAtS may have on other programs and procedures.

5.1 Organization and Staffing

There are no expected changes to staffing or official procedures at ATM facilities. However, AAtS may directly impact the way in which the FAA conducts business and makes decisions. In general, overall ATC workload may be lightened because of flight crews' increased access to advisory information. Pilots will have digital, on-demand access to this information, allowing ATC to focus on communicating command and control instructions, especially during major NAS events when frequencies are most congested. Decision making for TFM personnel will also be impacted. The transmission of flight performance profiles and atmospheric conditions data to the FAA, via AAtS, will better inform automation tools that will support decision making for TFM.

5.2 Cost Effectiveness

Financially, AAtS will have a minimal impact to the FAA due to most of the required infrastructure for implementation being in place today. AAtS will also provide the FAA a cost effective means for retrieving flight crew and aircraft generated data. It is assumed this cost will be part of the vendor provided service fee.

5.3 Environmental Impact

AAtS can support the FAAs effort to minimize the environmental footprint of the aviation industry. It has been shown that increased information access can reduce fuel-burn because of more efficient 4DTs, improved engine start times, or single engine taxi decisions.

5.4 Safety

Providing additional weather products and services to a flight crew and ensuring PIREPs are available in a timely fashion should have a positive impact on the safety of individual flights and the NAS as a whole.

5.5 Security

Certain SWIM data will not be available, via AAtS, to protect proprietary information and ensure the impact to FAA security is minimal. There is also infrastructure (i.e., NAS boundary protection services) currently in place to provide a secure interface between external users and NAS data and systems.

5.6 Capacity, Access and Equity, and Efficiency

Increased information distribution and access for individual aircraft can translate into positive NAS-wide impacts. The increased information will enable improved collaboration among the FAA and NAS users. This can lead to better management of demand at an airport which increases the relative capacity of that airport. It has been shown that airport and airspace access can also be increased as a result of improved collaboration. Especially among the GA community; in other words AAtS may help level the playing field between air carriers and GA. Positively impacting capacity, access, predictability and flexibility will lead to greater NAS-wide efficiency.

5.7 Global Interoperability

AAtS can support the FAAs effort to promote global harmonization for all future capabilities. The nature of AAtS (i.e., technologically flexible) lends itself to ensuring interoperability with international Air Navigation Service Providers.

5.8 Other Programs and Procedures

AAtS is expected to benefit several planned NextGen programs and procedures. For example, AAtS can alleviate potential bandwidth constraints for other programs, such as Data Comm, by being the mechanism for sharing advisory information that would otherwise be duplicated. AAtS can also be a means for data mining flight performance profiles and atmospheric conditions data to inform DSTs. Some NextGen initiatives, such as providing additional weather products and services to the cockpit, can be supplemented by AAtS efforts.

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Glossary of Terms

Advisory Information: Supplemental information that is not necessary for command and control of an aircraft. Not necessarily synonymous with ATM advisories such as TMIs issued by the ATCSCC.

Air Traffic Control: A function performed by controllers; concerned primarily with the safe, orderly, and expeditious flow of traffic by separating aircraft and providing pilots with supplemental information.

Air Traffic Management: This is a general term which encompasses both ATC and TFM

Airline Operations Center: A support center operated by a specific airline for the purpose of providing that airlines' fleet with flight management support (e.g., flight planning, advisory information, etc.)

Flight Crew: Refers to those individuals inside the cockpit responsible for operating the aircraft and accessing AAtS; includes both the Captain and First Officer in an air carrier flight.

Flight Deck: Refers to the infrastructure making up the cockpit to include the avionics of the aircraft.

Flight Operations Center: A GA support center operated by company personnel or a contracted "flight management company" for the purpose of providing that companies' fleet with flight management support (e.g., flight planning, advisory information, etc.)

Flight Performance Profile: The comprehensive data set describing the planned flight profile (i.e., 4DT) versus the actual flight profile, including how and why the two profiles differ (e.g., what caused a flight crew to divert to an alternate airport and who initiated the diversion).

Flight Service Station: A free FAA service to facilitate filing of flight plans, weather briefings, advisory information, etc.; most commonly used by non-supported GA flight crews.

Ground Operations: An encompassing term which may refer to FAA facilities (ARTCCs, TRACONs, ATCSCC, ATCTs, etc.), airport authorities/operations, AFSS and operations centers (AOCs/FOCs).

Traffic Flow Management: A function performed by Traffic Management Coordinators; the craft of managing the flow of air traffic in the NAS based on capacity and demand. The scope is larger than ATC and is usually a system view.

Acronyms

AAtS	Aircraft Access to SWIM
ACARS	Aircraft Communication Addressing and Reporting System
ADP	Aircrew Departure Papers
ADS-B	Automatic Dependent Surveillance – Broadcast
AFP	Airspace Flow Program
AFSS	Automated Flight Service Station
AIXM	Aeronautical Information eXchange Model
AOBT	Actual Off-Block Time
AOC	Airline Operations Center
ARTCC	Air Route Traffic Control Center
ASOS	Automated Surface Observing System
ATC	Air Traffic Control
ATCSCC	Air Traffic Control System Command Center
ATCT	Air Traffic Control Tower
ATIS	Automated Terminal Information Service
ATM	Air Traffic Management
ATOT	Actual Takeoff Time
AWOS	Automated Weather Observing System
CATM	Collaborative Air Traffic Management
CIWS	Corridor Integrated Weather System
ConOps	Concept of Operations
ConUse	Concept of Use
CWSU	Center Weather Service Unit
Data Comm	Data Communications
DEN	Denver International Airport
DMP	Departure Management Program
DMS	Data Management Service
DP	Departure Procedure
DST	Decision Support Tool
DTA	Delta VOR
EDCT	Expect Departure Clearance Time
EFB	Electronic Flight Bag
EOBT	Earliest Off-Block Time
ETA	Estimated Time of Arrival
ETG	Keating VOR
EWR	Newark International Airport
FAA	Federal Aviation Administration
FBO	Fixed Based Operator
FCA	Flow Constrained Area
FEA	Flow Evaluation Area
FIXM	Flight Information eXchange Model
FL	Flight Level
FMS	Flight Management System

FO	First Officer
FOC	Flight Operations Center
FSS	Flight Service Station
FTI	FAA Telecommunications Infrastructure
GA	General Aviation
GDP	Ground Delay Program
GRB	Green Bay VOR
GS	Ground Stop
HEF	Manassas Regional Airport
HPN	Westchester County Airport
IAD	Dulles International Airport
IFR	Instrument Flight Rules
IND	Indianapolis International Airport
IOBT	Initial Off-Block Time
ITWS	Integrated Terminal Weather System
JHW	Jamestown VOR
LGA	LaGuardia Airport
MCO	Orlando International Airport
MilAOC	Military Air Operations Center
MIA	Miami International Airport
MINIT	Minutes-in-Trail
MIT	Miles-in-Trail
MSL	Mean Sea Level
NAIMES	NAS Aeronautical Information Management Enterprise System
NAS	National Airspace System
NEXRAD	Next Generation Weather Radar System
NextGen	Next Generation Air Transportation System
NOTAM	Notice to Airmen
OI	Operational Improvement
ORD	Chicago O'Hare International Airport
ORF	Norfolk VOR
PCT	Potomac TRACON
PIREP	Pilot Report
RIC	Richmond International Airport
ROD	Rosewood VOR
SA	Situational Awareness
SAA	Special Activity Awareness
SOA	Service Oriented Architecture
SFO	San Francisco International Airport
SWIM	System Wide Information Management
TDWR	Terminal Doppler Weather Radar
TEB	Teterboro Airport
TELCON	Operational Planning Telephone Conference
TFM	Traffic Flow Management
TMAT	Target Movement Area Entry Time
TMI	Traffic Management Initiative

TMU	Traffic Management Unit
TRACON	Terminal Radar Approach Control
TVC	Traverse City VOR
UTC	Coordinated Universal Time
VFR	Visual Flight Rules
VHP	Indianapolis VOR
VMC	Visual Meteorological Conditions
VOR	Very High Frequency Omnidirectional Range
WXXM	Weather Information eXchange Model
ZAU	Chicago Center
ZBW	Boston Center
ZDC	Washington Center
ZID	Indianapolis Center
ZKC	Kansas City Center
ZNY	New York Center
ZOB	Cleveland Center
4DT	Four Dimensional Trajectory