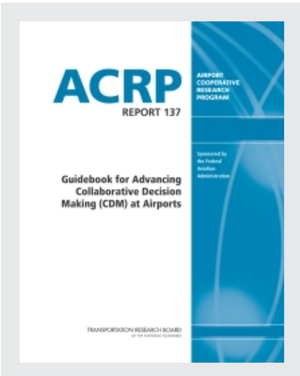

Guidebook for Advancing Collaborative Decision Making (CDM) at Airports

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AIRPORT COOPERATIVE RESEARCH PROGRAM

ACRP REPORT 137

Guidebook for Advancing Collaborative Decision Making (CDM) at Airports

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AIRPORT COOPERATIVE RESEARCH PROGRAM

Airports are vital national resources. They serve a key role in transportation of people and goods and in regional, national, and international commerce. They are where the nation's aviation system connects with other modes of transportation and where federal responsibility for managing and regulating air traffic operations intersects with the role of state and local governments that own and operate most airports. Research is necessary to solve common operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the airport industry. The Airport Cooperative Research Program (ACRP) serves as one of the principal means by which the airport industry can develop innovative near-term solutions to meet demands placed on it.

The need for ACRP was identified in *TRB Special Report 272: Airport Research Needs: Cooperative Solutions* in 2003, based on a study sponsored by the Federal Aviation Administration (FAA). The ACRP carries out applied research on problems that are shared by airport operating agencies and are not being adequately addressed by existing federal research programs. It is modeled after the successful National Cooperative Highway Research Program and Transit Cooperative Research Program. The ACRP undertakes research and other technical activities in a variety of airport subject areas, including design, construction, maintenance, operations, safety, security, policy, planning, human resources, and administration. The ACRP provides a forum where airport operators can cooperatively address common operational problems.

The ACRP was authorized in December 2003 as part of the Vision 100-Century of Aviation Reauthorization Act. The primary participants in the ACRP are (1) an independent governing board, the ACRP Oversight Committee (AOC), appointed by the Secretary of the U.S. Department of Transportation with representation from airport operating agencies, other stakeholders, and relevant industry organizations such as the Airports Council International-North America (ACI-NA), the American Association of Airport Executives (AAAE), the National Association of State Aviation Officials (NASAO), Airlines for America (A4A), and the Airport Consultants Council (ACC) as vital links to the airport community; (2) the TRB as program manager and secretariat for the governing board; and (3) the FAA as program sponsor. In October 2005, the FAA executed a contract with the National Academies formally initiating the program.

The ACRP benefits from the cooperation and participation of airport professionals, air carriers, shippers, state and local government officials, equipment and service suppliers, other airport users, and research organizations. Each of these participants has different interests and responsibilities, and each is an integral part of this cooperative research effort.

Research problem statements for the ACRP are solicited periodically but may be submitted to the TRB by anyone at any time. It is the responsibility of the AOC to formulate the research program by identifying the highest priority projects and defining funding levels and expected products.

Once selected, each ACRP project is assigned to an expert panel, appointed by the TRB. Panels include experienced practitioners and research specialists; heavy emphasis is placed on including airport professionals, the intended users of the research products. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, ACRP project panels serve voluntarily without compensation.

Primary emphasis is placed on disseminating ACRP results to the intended end-users of the research: airport operating agencies, service providers, and suppliers. The ACRP produces a series of research reports for use by airport operators, local agencies, the FAA, and other interested parties, and industry associations may arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by airport-industry practitioners.

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The members of the technical panel selected to monitor this project and to review this report were chosen for their special competencies and with regard for appropriate balance. The report was reviewed by the technical panel and accepted for publication according to procedures established and overseen by the Transportation Research Board and approved by the Governing Board of the National Research Council.

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FOREWORD

By Marci A. Greenberger
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ACRP Report 137: *Guidebook for Advancing Collaborative Decision Making (CDM) at Airports* provides guidance to airport operators about the value of and how to integrate CDM into operations. CDM, or ACDM to refer to airport collaborative decision making, is the process of data sharing whereby airports, airlines, other stakeholders, and the air navigation service provider (i.e., FAA Air Traffic Control) share information to make operational decisions. While the airlines and the FAA have considerable experience in using CDM, airports have not typically been participants.

New technologies that make it easier for airports to obtain information and for other stakeholders to exchange information with airports, have allowed airports to play a more direct role in CDM. As airports have had an opportunity to participate in CDM activities, they have been able to achieve efficiencies for their daily operations and improve their effectiveness in their IROPS (Irregular Operations) activities.

The Guidebook provides a history of CDM, both in the United States and abroad, a background on the issues, the tools that can be used, when it can be used, and the benefits. The Guidebook discusses the different stakeholders and their role, guides the user for implementation, and provides lessons learned.

Traffic management CDM between flight operators and the FAA has been in existence since the mid-1990s. Recent surface traffic management projects have demonstrated the potential efficiency and environmental benefits that can be realized from including other aviation stakeholders, including airports, into the CDM process.

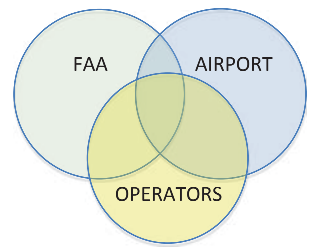
As airports have become active in CDM activities, they have found it useful in managing aircraft movements, gate management, ground service equipment coordination, de-icing operations, special events, tarmac delays, and IROPS. ACDM is thought to be a tool and a means of coordination through technology that is only applicable and attainable by the larger airports; however, it can be used by smaller airports as it assists all size airports with their situational awareness. Smaller airports can be greatly impacted during IROPS and it is their ability to have information quicker that allows them to activate their plan sooner and presumably more effectively with the least amount of impact on the airport's operations or the affected passengers.

Mosaic ATM, Inc., as part of ACRP Project 10-19 "Advancing Collaborative Decision Making (CDM) at Airports" was tasked with conducting research from U.S. airports and European airports that use CDM and to develop a Guidebook for airport operators. This Guidebook will be useful to airport operations staff at all size airports to assist them in integrating ACDM into operations and how to work with stakeholders.

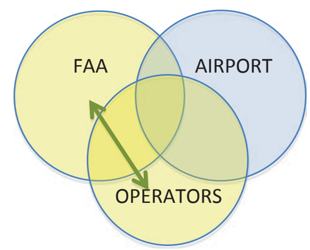
CONTENTS

Note: Photographs, figures, and tables in this report may have been converted from color to grayscale for printing. The electronic version of the report (posted on the web at www.trb.org) retains the color versions.

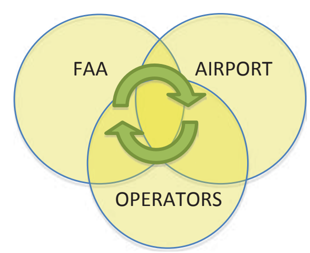
Introduction—Airport Collaborative Decision Making (ACDM)



In a Collaborative Decision Making (CDM) context, there are three distinct leadership groups: the FAA, the airport operator, and the flight operators. Each of these groups represents different constituents as they strive for an efficient, timely operation and work to solve issues related to aircraft surface operations at airports. The collaboration of these efforts is discussed at length in this Guidebook. Prior to the establishment of CDM in the early 1990s, these leadership groups worked in what today is described as stovepipes. Exchange of real-time, day-of-operations information between the groups was limited.



In the mid-1990s, as delays in the National Airspace System (NAS) grew, the FAA and flight operators came to realize that internal real-time operational decisions had a great deal of external impact on one another. As this understanding deepened, they realized that decisions were being made without full and complete information and collaboration. To bridge this gap, the FAA/Industry CDM group was established to collaborate and share real-time operational information to improve situational awareness and decision making. From this beginning, the FAA and flight operators have expanded, enhanced, and modified the processes of CDM into a body of work that has substantially improved the efficiency and safety of air traffic management.



This air traffic management collaboration has now evolved to include airport surface traffic management. This FAA Industry CDM activity has realized that comprehensive industry collaboration must extend to the aircraft parking gate. Thus, airport operators are also a vital link in the efforts to reduce delay and improve safety and efficiency. Airport CDM is the extension of the CDM philosophy of information sharing to problems touching airports. Table 1 illustrates a few examples of airport information sharing between stakeholders that could produce an efficient result.

In this Guidebook, we expand on these and other matters to illustrate the methods and benefits of airports being included in the desired end state of operational collaboration and information sharing. This will, in turn, enhance the operational decision making of all concerned. All three airport leadership groups, the FAA, the flight operator, and airport operators, have a role in providing the safest and most efficient service to the end-state customer—the person paying for the services rendered.

Table 1. Information sharing and collaborative result examples.

Information Shared	Collaborative Result
Advance prediction of departure readiness from ramp towers and/or flight operators prior to push-back from the parking gate.	Instead of **reacting** to a request for air traffic service at push-back, Air Traffic Control (ATC) can plan **proactively** the most efficient departure sequence.
Accurate estimated time of arrivals on international flights combined with passenger manifest numbers.	Timely predictions of demand on Customs and Border Protection (CBP) clearance points to facilitate correct staffing.
Real-time FAA flight data changes.	More advance notice and better planning for flight diversions due to severe/winter weather, reducing impact of diversions on airport resources.
Departure queue length, FAA Air Traffic Control System Command Center (ATCSCC) traffic management information (restrictions and delays), and real-time flight operator schedules and adjustments.	Mitigating FAR 117 (crew duty time) and tarmac rule impact. Reduce environmental impact of emissions and noise with less taxi time.
Landing runway and highly accurate estimates of landing time.	More efficient ramp movement of traffic with advanced predictions of demand on ramp alleyways and gates with restricted access, leading to better aircraft parking gate utilization.

CHAPTER 1

Overview of CDM

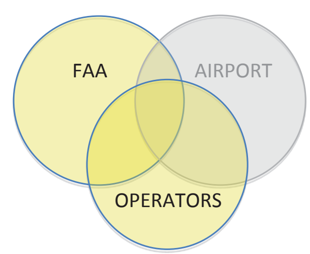
Brief Overview of CDM History

In this section, a brief overview of the FAA/Industry Collaborative Decision Making (CDM) program is presented to facilitate the understanding of the development of CDM. A thorough, detailed history is presented for the reader's information in the following section.

The evolution of the FAA/Industry CDM program is shown in Figure 1. In the mid-1990s, the FAA and flight operators came to the understanding that there had to be a more efficient way of conducting business. Missing or incorrect information was being used for decision making. For example, the FAA was using the Official Airline Guide (OAG) to forecast daily demand while the flight operators were using internal real-time data to adjust the schedules causing significant deviations from the OAG. In 1995, the FAA/Industry CDM program was officially initiated. In 1996, the FAA and industry developed graphical displays of air traffic demand that greatly facilitated collaboration. In 1997, a common AOC (Airline Operations Center) network (AOCnet) was established to facilitate distribution of demand and delay data between not only the FAA and AOCs but also between AOCs.

The benefits of collaboration were immediate because, for the first time, decision-makers understood what was occurring in the entire NAS, not just in their segment. From that point on, collaboration and participation increased; tools were developed not only to facilitate collaboration but to allow the users to substitute delays between flights in order to enact business preferences. CDM became a philosophy of operations.

Historical Development of CDM



Though it was not called CDM at the time, Collaborative Decision Making began in 1993 when the FAA and major users of the NAS came to a consensus that the air traffic management system would operate more efficiently if planning were based on real-time airline schedules. Prior to that time, the FAA had used schedules as published in the OAG to forecast preliminary air traffic demand prior to operators filing actual flight plans. One of the first successes of CDM was when industry agreed to share real-time, day-of-operations schedules so that more accurate forecasting of air traffic demand could be obtained for managing operations.

In 1995, CDM was officially established when a joint FAA/industry group defined roles and responsibilities for CDM, and the foundation for a collaborative air traffic management system was laid. Memoranda of Understanding (MOUs) were signed by both the FAA and various NAS users to codify these relationships. The MOUs detailed that CDM membership was restricted to the FAA and to NAS users who exchanged air traffic movement data with the FAA—**airports were not included.** The airport exclusion was not intentional; rather it was based on the MOUs

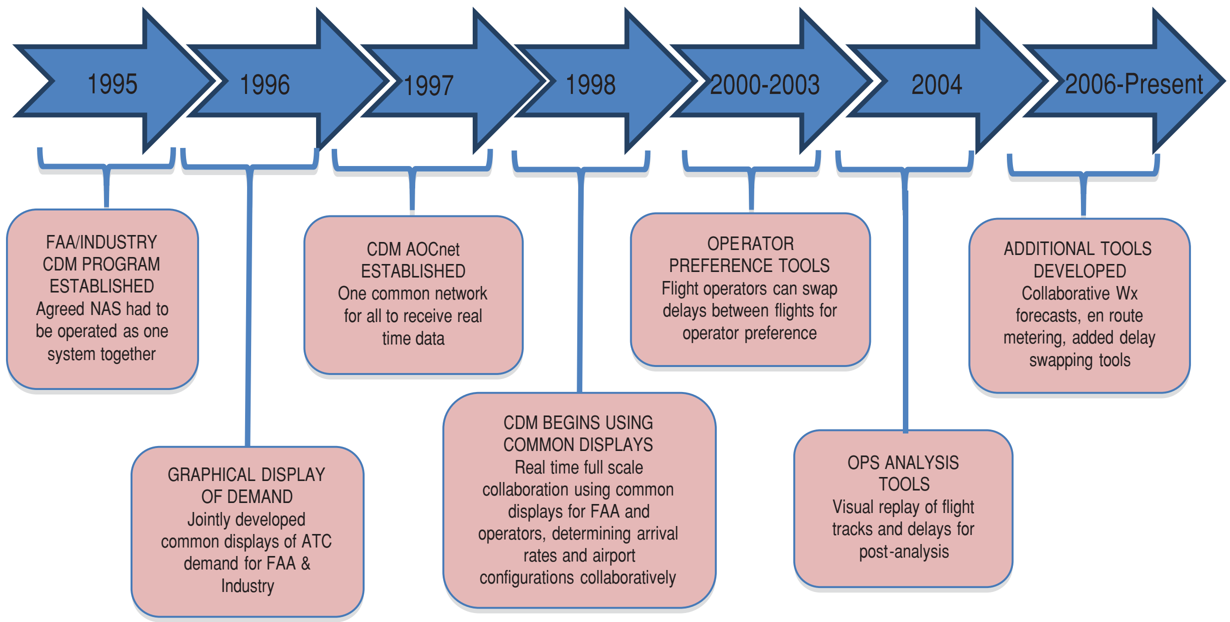


Figure 1. FAA/Industry CDM program development timeline.

requirements of stringent data exchange standards, and excluded vendor conflicts of interest. The move toward establishing CDM was further reinforced in 1995 by the Radio Technical Commission for Aeronautics (RTCA) Task Force 3 Free Flight Action Plan. Many of the Task Force 3 recommendations identified the need for joint planning and collaboration to ensure the efficient movement of air traffic.

In 1996, the joint FAA/Industry CDM group defined the requirements for displaying air traffic demand to FAA traffic managers and flight operators, leading to the creation of the Flight Schedule Monitor (FSM) tool (Figure 2). The major attributes that FSM depicts are as follows:

- Expected airport demand in time increments as small as 15 minutes.
- Status of the demand, e.g., scheduled (green), active (red).
- Degree of demand over/under capacity (white line indicates capacity).
- Degree of demand that did not become active as scheduled (dark green).
- The amount of delayed demand and the impact of delaying that demand.
- Ability to illustrate the impact of demand vs. various capacity scenarios.

FSM was a major breakthrough in the establishment of CDM. For the first time, NAS users had access to real-time operational information from both the FAA and flight operators. FSM enabled capturing real-time capacity through information exchanges, where previously decisions had been made on less accurate data, causing inefficiencies such as uncaptured capacity. Additionally, FSM detailed the down-line impacts of Ground Delay Programs (GDPs) for both the users and FAA traffic management personnel. The effectiveness of FSM eliminated much of the original mistrust of data sharing. Following this initial success, CDM became enshrined as a necessity rather than just another program.

As time passed, joint FAA/Industry work groups were established and expanded under the auspices of CDM. Requirements for CDM membership were formally established, and funding was guaranteed as a line item in the FAA budget. These events, first introduced in Figure 1, are described in the text below.

1997—AOCnet was established, allowing NAS status (e.g., demand, delays, restrictions) information to be uniformly relayed in real-time to flight operators.

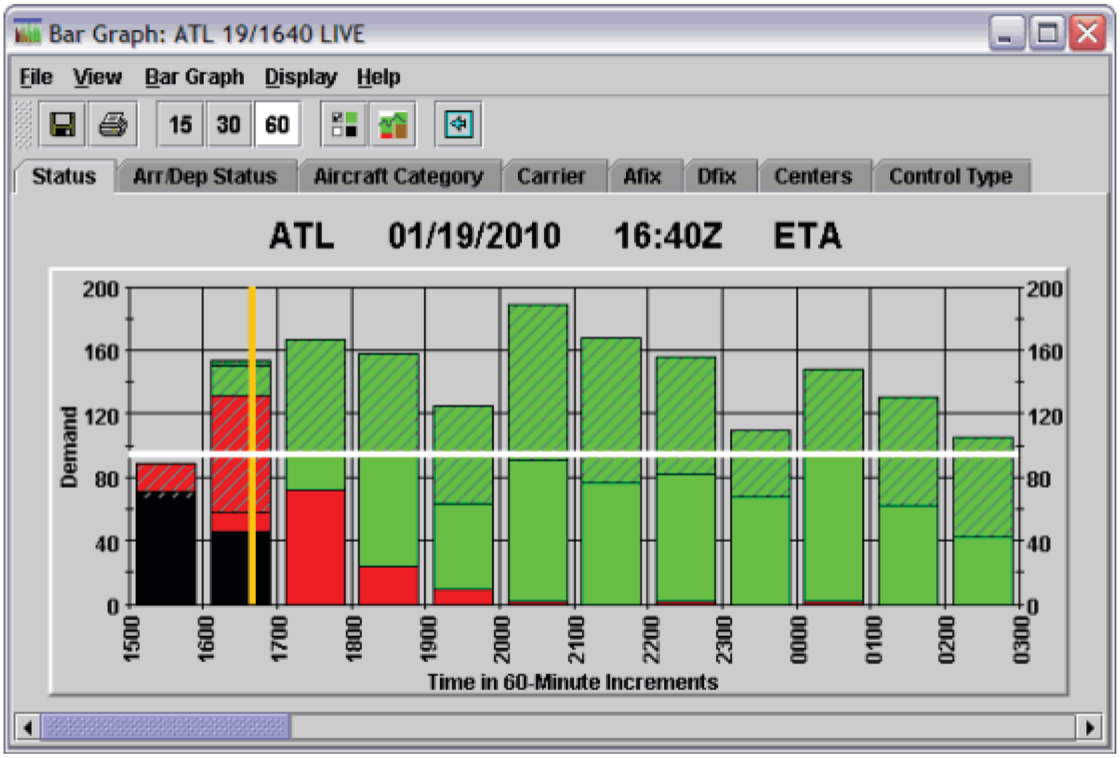


Figure 2. Typical flight schedule monitor display for Hartsfield-Jackson Atlanta International Airport (Metron Aviation 2014).

1998—Prototype collaboration for busy airports began with conference calls, data exchanges, and collaboration on appropriate airport configurations.

1999—The Volpe National Transportation Systems Center established the CDM Hub site to facilitate data exchange.

2000–2003—Development of CDM initiatives proceeded rapidly, including airline flight substitution—substitute one delayed flight for another in a modified schedule to enhance company business objectives.

2004—The Post Operations Evaluation Tool (POET) was established. Prior to the creation of this tool, post-analysis of flight performance (route and altitude flown and delay encountered) was very difficult. POET presented a database where specific queries could be made concerning specific flights, or groups thereof. These queries led to open and forthright evaluations of both FAA and NAS user operations.

2006—The Airspace Flow Program (AFP) was established. Previously en route constraints could only be moderated with airport GDPs. This concentrated the delays on users of major airports where no constraint existed. AFP identified flights through the constrained area and distributed delay equally.

2007–2013—CDM continued to develop, adapt, and evolve many programs:

- Adaptive Compression—Identifies flight list characteristics for compression to ensure that all available slots are utilized.
- Collaborative Convective Forecast Product—Collaborative forecasting of weather that will constrain air traffic by FAA and industry experts, including the agreed degree of the constraint.
- Re-route tools.
- Weather forecasting products.

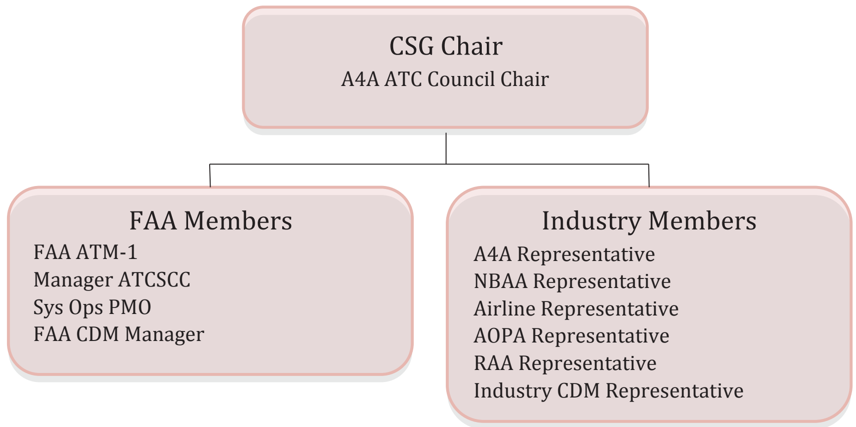


Figure 3. Governance of CDM by CDM Steering Group.

- Collaborative Trajectory Options Set (CTOP)—Allows the NAS user to propose several route options for a flight and to predetermine the delay, making each option the preferred option.
- Surface traffic management concept of operations.

2009—The CDM Steering Group (CSG) was established, which formalized some of the relationships that had developed in the previous rounds of CDM activities. The formal structure is depicted in Figure 3. The purpose of the CSG is to develop the most productive air traffic management ideas by allocating CDM resources from both the FAA and Industry into the most effective projects. This is accomplished by tasking specific teams, assigning appropriate personnel, and providing regular reports to the CSG. In other words, the CSG is an administrative body controlling and regulating the work of the CDM teams. The teams are initiated by the task at hand and have a defined lifespan. The current teams are as follows:

- Flow Evaluation Team—Reviews current en route operations and automation usage and suggests improvements.
- Future Concepts—Identifies and develops future concepts.
- Training—Develops training for joint FAA/NAS tools and concepts.
- Weather Concepts—Works to improve forecasting.
- Collaborative Automation Team—Automation and integration issues.
- Surface Concepts—Developing surface traffic management concept of operations, focused primarily on departure metering procedures.

Current CDM Membership Requirements

CDM membership is limited to qualified aviation-related entities that meet the data sharing criteria (data that CDM determines is needed to operate the NAS more effectively). Due to the traffic management emphasis when CDM was originally formed, airports were not considered as having pertinent data to share. This is due to the fact that shared data was and is subject to the following rules:

- CDM data is based on industry data and is considered proprietary.
- CDM data is the property of the industry and cannot be released without the approval of the data providers.
- CDM data is intended to support daily management of aircraft flight operations.
- Only aircraft operators that provide individual CDM data will receive aggregate FAA CDM data; FAA will provide the proprietary CDM data to CDM participants only.

- All CDM participants are required to sign the CDM Memorandum of Agreement (MOA) effective March 1, 2009.

The reasoning behind these data sharing restrictions is to ensure that a participant shared all pertinent data and does not have to be concerned that the data shared would be used in some negative manner. CDM emphasizes the trust of its participants to collaboratively share data to solve problems. This trust is essential in any type of CDM process.

At the present, all CDM participants are responsible for the following:

- All required training and documentation.
- Software, as needed, to display and integrate CDM data in their individual systems.
- Connection and alignment of CDM data communication interfaces.
- Testing of data exchange capabilities.

How Do CDM Activities Relate to Airport Operations?

As is made apparent through its history, CDM, especially in the beginning, concentrated on traffic management initiatives and not on airport operations. In 2003, as a result of the FAA Free Flight project and NASA research and development, initiatives began studying surface traffic management. Tools, multi-lateration (triangulation of aircraft transponder signals) surveillance in particular, were deployed, and the benefits of common surface situational awareness led to significant industry interest in surface traffic management. This interest led to adjustments in the FAA Airport Surface Detection Equipment, Model X (ASDE-X) program to include usage of its surveillance ability, by airports and flight operators, to formulate surface management initiatives.

In 2009, RTCA Task Force 5 (NextGen Task Force) declared surface traffic management one of its primary recommendations, and as a result, the FAA established the Surface Office in the System Operations organization. During this period and because of this activity and interest, the CSG established the Surface Concepts Team (SCT).

The first tasking for the SCT was to develop a concept of operations for surface traffic management, which represented a new focus for CDM on airport operations. In 2013, the SCT had completed this assignment and was holding Human-in-the-Loop Simulations (HITLs) to test concepts for metering flight departure demand from the parking gate. Successful departure metering requires movement predictions and information from several sources, thus this concept is one of the most visible examples of ACDM.

HITLs are a significant expense and are being funded by the FAA, with system users (airlines and NBAA) and one airport operator providing additional expertise. The latest version of this concept is dated July 2013 and details a number of activities that involve the ingress and egress timing and control of aircraft to/from the Movement Area of an airport. These operational HITLs are trying to answer questions such as:

- Who is best suited to operate the departure metering position: the airport operator, flight operators, or the FAA?
- At busy airports, how can the combined operations of multiple ramp towers to stage departing aircraft contribute to FAA control tower operational improvements?
- How can departure capacity be distributed when the combined schedule of all operators, including general/business aviation, exceeds the capacity of the airport?
- How is a flight that for some reason does not meet its controlled time, assigned a new time without a significant delay?
- Should capacity be regulated by limiting the number of aircraft in a specific time period or by assigning a specific time to all aircraft?

- How would swapping of allocated departure times between operators be regulated?
- Do the answers to these and many other questions differ from airport to airport?

Some of these concepts require introducing control of aircraft movement activities in the Non-Movement Area, such as for push-back from the aircraft parking gate, specific times and locations for aircraft to be staged to enter the Movement Area, specific order of staging aircraft for entry into the Movement Area, flight departure readiness alerts, etc. Previously the Non-Movement Areas, where the airports and their vendors have the most activity, were not controlled by the FAA or by CDM processes.

Introducing these control measures for Non-Movement Areas requires the participation of everyone involved with or enabling aircraft movement, including the FAA, flight operators, and airport operators and their respective vendors.

Definition of ACDM

This Guidebook defines Airport Collaborative Decision Making (ACDM) as a process, bringing together relevant airport stakeholders to improve operational decision making and share information, to enhance surface movement of air traffic, to reduce emissions and noise from aircraft engines, to mitigate events such as construction in the airport surface Movement Area, and to ensure that the airport system provides benefits for all. It achieves these objectives through collaboration among stakeholders, particularly related to data sharing in a real-time environment. ACDM brings together air carriers, airports, government, private industry, and academia in an effort to improve efficiency and to reduce detrimental impacts to flight operations. The success of ACDM activities is determined through appropriate metrics, as is the case for all FAA/Industry CDM activities.

An example of this ACDM definition is the implementation of a Performance-Based Navigation (PBN) procedure. Utilizing the advanced navigation equipage capability on newer airplanes, procedures can be developed that reduce workload and reduce low altitude flying, which reduces fuel burn engine noise and associated emissions. A quick glance at PBN might erroneously indicate that if the FAA ATC facility and the flight operator technically agree on the procedure, it could be implemented. Experience has shown that PBN implementation requires a truly collaborative and inclusive effort since PBN implementations usually result in the following issues:

- New obstruction clearance conformance required of airports
- The need for significant community outreach because flight paths will change, thus resulting in new noise exposure
- Regulatory issues reference environmental impacts including impact on previous agreements both official and voluntary
- Political exposure to community leaders
- Training needs of all types.

ACDM is a philosophy—not a particular project.

ACDM Operations Today

No airport in the United States has fully deployed and thus totally optimized all surface air traffic movements via the ACDM process. There have been several individual airport one-of-a-kind trials and decision support tool tests to partly enable or facilitate ACDM. These trial and decision support tool tests can be divided into three categories.

Actual ACDM Technology Tool Deployment

The prime example in the United States is the ground departure-metering tool employed at JFK International Airport, initiated by the Port Authority of New York and New Jersey (PANYNJ) and operated and staffed under a contract with the PANYNJ (see Appendix C for details). The focus of this ground departure-metering tool is to control/limit the number of departing aircraft queued on an active taxiway at any one time. This simplifies the Air Traffic Control Tower (ATCT) workload, thus increasing the ability to efficiently sequence departures, and promotes fuel conservation and reduces emissions through reduced taxi time. Through monitoring and collaboration, it also provides an accurate real-time gauge of departure demand and facilitates planning to handle said demand and thus reduces taxi time and fuel burn. The effectiveness of this departure metering operation is inhibited by the lack of real-time ATC movement restrictions impacting departures. Thus the ground departure metering function is metering flights without consideration of ATC traffic management restrictions. This lack of information is discussed in various workgroups dealing with surface traffic management issues and is tentatively scheduled to be addressed in 2015.

Research projects using decision support tools to control push-back timing from the gate and to manage departure queues have been initiated at some U.S. airports (Collaborative Departure Queue Management at Memphis International and Orlando International Airports, severe weather reroutes at George Bush Intercontinental Airport, changing departure routes at Newark Liberty International Airport, and Pre-Departure Release Control (PDRC) at Dallas/Fort Worth International Airport). While these systems have shown benefit potential, they have not been fully developed; therefore, there has not yet been a full-scale deployment.

Commercial Tools Leased/Purchased by the Airport or a Specific Operator

These commercial tools are generally used to improve situational awareness applications, and their specific usage varies from airport to airport. At some locations, these tools have been locally adapted to perform specific tasks such as:

- A tool utilizing privately installed multi-lateration antennas and flight matching capabilities, generating a real-time display of aircraft movements on or around the airport, which allows the user to gauge real-time positioning of flights for gate and ramp management.
- An airborne tracking of flights using a slightly delayed feed from the FAA Aircraft Situation Display feed or real-time positioning via ADS-B generated information.
- Airborne tracking of flights decision support tool that provides alerts for such activities as entering holding, diversion, or change of destination.

Some local airport customization of these tools for local needs has been accomplished and includes the following:

- Display of flight(s) requiring rerouting around severe weather and identification of flight(s) that have received the appropriate re-route, and
- Aircraft de-icing status.

Tools Not Intended for ACDM Technology but Sometimes Utilized as Such

Several airports or users at some airports have coordinated with the local ATC facility and have automation displays/feeds from FAA systems to mitigate airport-specific issues. These solutions are non-standard and not readily transferable to other airports. These include information access from the following capabilities:

- ASDE-X, which provides the real-time position of all flights on the Movement Area of an airport;
- Local area ATC radar; and
- Information Display Systems (FAA internal displays) that provide controllers needed information on traffic management initiatives and restrictions.

Many airports have Flight Information Displays (FIDs). There are several types of FIDs. In addition to passenger information displays, these systems are utilized to relay parking position information to various vendors operating on the airport ramp areas.

Many operators display countdown parameters at each gate. These display flight number, destination, countdown to departure, etc., and are used to collaborate ramp activities toward on-time departure readiness. Such systems could be used to gauge an Estimated Off Block Time (EOBT), but such information is usually held internally.

International ACDM

ACDM efforts have been undertaken at several airports around the world. In general, the motivations are similar: reducing runway queues and taxi times, and as a result, decreasing environmental impacts. However, ACDM activities do differ in other world locations, due primarily to the very different operational and governance structures in place. Thus, while significant differences exist, a few examples of other ACDM efforts are described in this section, with hopes that they may help motivate the adoption of ACDM programs at U.S. airports.

The International Civil Aviation Organization (ICAO) has been working to develop some standards for ACDM that may be applied around the world, including influencing developments within the United States. Their initial guidance covers many of the same issues addressed in the Guidebook, although final guidance documents are not expected until at least 2015 (ICAO 2012).

Europe

The European Organization for the Safety of Air Navigation (EUROCONTROL) has an official ACDM program. To quote their web site (EUROCONTROL 2014):

> "ACDM is about partners—airport operators, aircraft operators, ground handlers, air traffic control and the Network Manager—working together more efficiently and transparently in how they work and share data. It allows better decision making, based on more accurate and timely information, with all airport partners having the same operational picture.
>
> The benefits are visible at a network level, with more accurate take-off information feeding into the air traffic flow and capacity management system run by EUROCONTROL's Network Management. The network will be able to use the available capacity more efficiently. More effective use of slots results in reduced delays, improved predictability of events during a flight and optimized use of resources at airports."

The joint publication entitled "Airport CDM," issued by Airport Council International, EUROCONTROL, and IATA, states (EUROCONTROL 2009):

> "the right information at the right time to the right people. Each partner has at some point a piece of information that is more up-to-date and more reliable than the estimates used by other partners; yet all too often this better information is not shared. CDM information sharing helps to create common situational awareness by making this information visible to those that are affected by it."

The above quotes are graphically depicted in Figure 4 which is taken directly from the EUROCONTROL ACDM implementation manual (EUROCONTROL 2012).

The EUROCONTROL target is to reduce the taxi time of every aircraft by three minutes and thereby gain both efficiency and environmental benefits.

The advent of this program resulted from a research and development effort at Flughafen München Airport (Munich, Germany). As in most parts of Europe, the airport controls gate assignment for flights, with many of the same gates being used by different operators at different times of the day. The Munich Airport community developed an ACDM program so that gate usage, which is obviously impacted by traffic management regulations (the U.S. refers to these regulations as restrictions), could be coordinated and planned around EUROCONTROL regulations. The Munich Airport effort detailed many benefits of such an approach, but also illustrated the need for the entire community, including the airlines, to be involved for the best product. It also revealed that how an airport operates would dictate who is needed to be involved in the ACDM community.

Paris Charles de Gaulle Airport enacted an ACDM effort where some, but not all, users are provided with a means for data entry to display maintenance delays and other factors involved in departure readiness. Additionally, the same users receive data such as departure runway and queue length. This effort originally only involved two airlines (Air France and FedEx) for test purposes and is being expanded as lessons are learned and systems and techniques are refined.

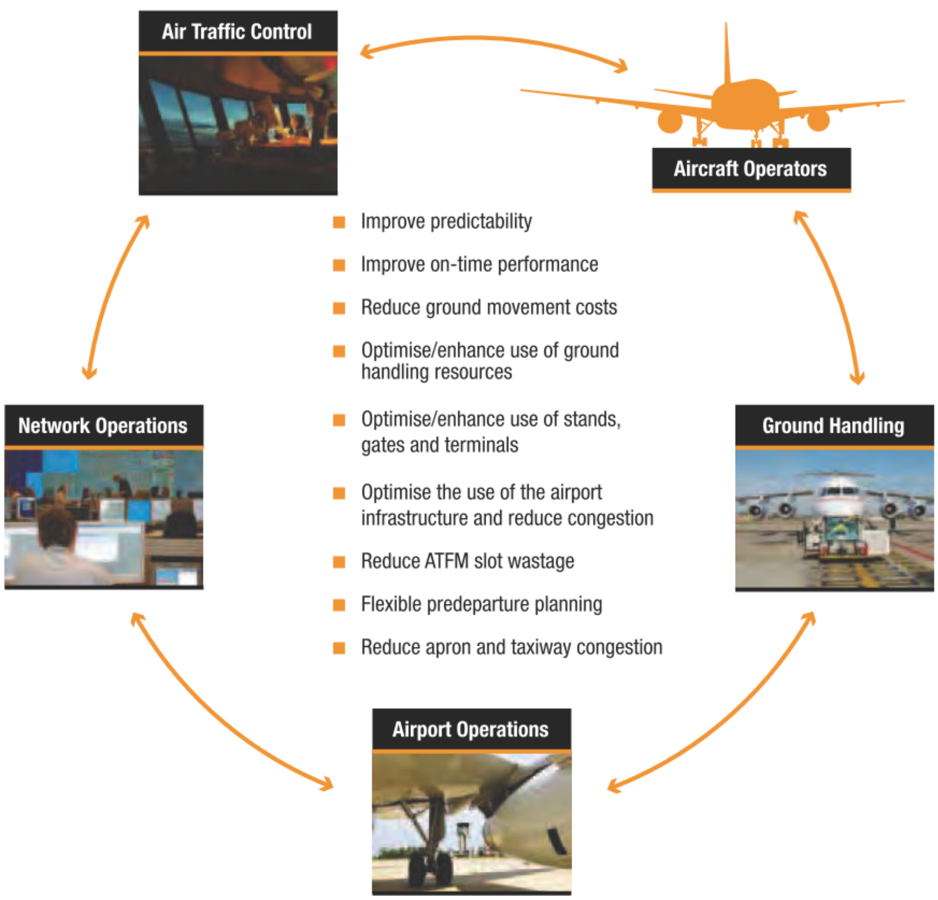


Figure 4. EUROCONTROL ACDM objectives (EUROCONTROL 2012).

Table 2. Benefits reported by early adopters of airport CDM in Europe (EUROCONTROL 2013).

SAVINGS	BENEFICIARIES
Brussels	
▪ **Absorption of delay at the gate and no longer at the runway resulted in annual savings of:**	
- **17,022 metric tons (t) of CO_2**	Aircraft Operator, Airport Community
- **22 t of NOx**	Aircraft Operator, Airport Community
- **5,400 t of fuel**	Aircraft Operator
- **2.7M €/year in fuel saving**	Aircraft Operator
▪ **Average reduction of taxi time outbound: 3 minutes**	Aircraft Operator, Airport Operator, Air Navigation Service Provider
Munich	
▪ **Average ATFM slot adherence 93% in 2011**	Aircraft Operator, Airport Operator, Air Navigation Service Provider
▪ **10% average reduction in taxi time**	Aircraft Operator, Airport Operator
▪ **2.65M €/year in fuel saving**	Aircraft Operator
Paris Charles de Gaulle	
▪ **Average taxi-out time reduction by 2 minutes and 4 minutes in Adverse Conditions**	Aircraft Operator, Airport Operator
▪ **Reduced fuel consumption: 14 t/day**	Aircraft Operator
▪ **Reduced emissions: 44 t CO_2/day**	Aircraft Operator, Airport Community
Frankfurt	
▪ **Improved runway usage and take-off flow**	Aircraft Operator, Airport Operator, Air Navigation Service Provider
▪ **Reduction of the impact of arrival delay leading to a more punctual departure and stable TOBT process**	Aircraft Operator, Airport Operator, Air Navigation Service Provider

A detailed statistical analysis of taxi times has been conducted at Paris Charles de Gaulle. This analysis resulted in an expanded and fine-tuned taxi time table, taking into account the aircraft category, in support of estimating a more accurate time at threshold (Andreeff 2014).

The European departure metering systems differ from U.S. systems because flight operators in Europe generate many more data points than U.S. operations, e.g., EOBT, COBT (Controlled Off Block Time), and TOBT (Target Off Block Time). ACDM efforts in Europe are underway at Munich, Brussels, Paris Charles de Gaulle, Frankfurt, London-Heathrow, Helsinki, Düsseldorf, and Zurich airports with others expected in the future.

The European CDM community has developed its own informational material on implementing Airport CDM. Their guidebook (EUROCONTROL 2009) was developed in collaboration with Airports Council International Europe and the International Air Transport Association. This document documents best practices; benefits (complete with quantitative examples); and descriptions of the experiences and lessons learned from airports that were early adopters of CDM in Europe. Table 2 summarizes some of the specific benefits reported from the European airport community.

China

China has instituted Airport CDM programs at most major airports. This was a result of growing ATC flight departure delays. This ACDM program did not significantly reduce delays, but did emphasize the fact that delays from major Chinese airports resulted from airspace constraints and limitations on airspace availability to commercial aviation usage.

Japan

ACDM in Japan concentrates on environmental issues such as reduced emissions from taxiing aircraft due to emphasis on conformance to the Kyoto Protocol. The effort is in an organizational stage with workshops and educational programs being initiated beginning in Fall 2013. Specific system-wide procedures for all Japanese airports have not yet been initiated.

ACDM in the Future

The direction of ACDM, and departure metering in particular, in the future could and probably will take several paths.

- The airport may contract for specific placement (in airport control centers, local operation centers, Fixed Base Operators, police and fire stations, etc.) of movement and control displays to improve everyone's situational awareness.
- The FAA may develop decision support tools and data managers such as the Tower Flight Data Manager (TFDM) program to better forecast arrival and departure demand and decision making, which includes control and support of efficient flight movement from departure gate to arrival gate.
- The CDM community, including the FAA, may continue to develop, refine, and test its Concept of Operation for surface traffic management.

The future of ACDM can probably be reflected best by the following quotes from the "Surface CDM Concept of Operations" (FAA 2014a). It is a future with many facets and applications, but certainly involves airports.

> "The implementation of the Surface CDM concept is a pivotal component to improving the efficiency of traffic flows on the surface at U.S. airports, and achieving operational benefits across the entire NAS. Surface CDM progresses the FAA's NextGen Implementation Plan (NGIP) [2] [3] [4] [5], which aims to provide advanced capabilities that make air transportation even more safe and reliable while improving the capacity of the National Airspace System (NAS), reducing the impact of aviation on the environment, and improving the experience of the traveling public."
>
> "Understanding that 'once you've seen one airport, you've seen one airport,' the concept recognizes that implementation of Surface CDM may include the full suite of capabilities and procedures, or a subset of capabilities and procedures, in accordance with the needs and expected benefits at a particular airport. The full complement of capabilities includes:
>
> - Situational awareness among all Stakeholders to facilitate continuous, accurate predictability of airport demand and capacity through transparent, real-time sharing of current and forecast operational information.
> - Strategic management of airport surface traffic flows and departure runway queues, thereby avoiding excessive taxi-out times, reducing emissions and optimizing airport capacity.
> - Management of airport surface arrival traffic flows that reflect known Departure Metering Procedures (DMPs) and predicted gate conflict information which optimizes available airport capacity.
> - Analysis, measurement, and monitoring capabilities that position stakeholders to better understand local airport operational performance and the impact on the NAS, utilizing a 'Scorecard' that provides an objective, transparent measurement of the performance of each of the local stakeholders.
> - Global harmonization and interoperability which facilitates interoperability across international Airport CDM programs and the FAA's Surface CDM concept."

From this historical review, it is obvious that ACDM concepts will evolve just as the FAA/Industry CDM program has done. The ACDM evolution should not require the same lengthy timeframe since terminology, concepts, and data security issues can be directly transferred from the FAA/Industry CDM program.

CHAPTER 2

Terminology, Required Data, and Security

At the heart of ACDM is data sharing between the various members of the airport community. To facilitate such data sharing, efforts have been made to standardize the names and definitions of the commonly used data elements across programs and airports. This chapter introduces and defines those terms that are most commonly used in ACDM and reviews the security issues involved in data sharing.

Terminology

The nomenclature of ACDM relies heavily on the use of acronyms. Additional terms and acronyms are presented in Appendix A.

AOBT—Actual Off Block Time is the time the aircraft vacates its parking position to begin taxi for departure.

ASDE-X—Airport Surface Detection Equipment Model X is a system that uses a combination of triangulation of aircraft transponder signals (termed multi-lateration), aircraft Automatic Dependent Surveillance Broadcast (ADS-B) broadcasts, and primary radar reflections to present an airport and surrounding airspace display of the position of all aircraft and includes individual data tags indicating flight identification, aircraft tail number, and other associated flight data. The update rate for this display is between one (1) and two (2) seconds.

DRC—Departure Reservoir Coordinator is the position that utilizes readiness information and times the release of the departing aircraft from the parking or ramp area to achieve efficient aircraft taxiing and desired departure queuing so ATCT can achieve ACDM aims and objectives.

EOBT—Estimated Off Block Time is the earliest time that the aircraft is available and ready to begin movement from the parking position. This time is utilized to forecast taxiing and departure demand so that the DRC can plan in advance and sequence an efficient and orderly departure flow.

ESP—En Route Spacing Program is a program that results in generating and enacting a specific departure time or range of departure times in order to sequence a departing aircraft's position relative to other aircraft into the overhead stream that are subject to the same FAA traffic management restrictions. For example, if a certain timing or miles in trail is required for a specific airport, then the ESP program will look for a gap in the overhead stream and will issue a departure time or range for the departure to fit into that gap.

ETOT—Estimated Take-Off Time is a calculated take-off time that is determined by adding the expected taxi time to the EOBT or TMAT as appropriate. This enables the DRC to issue a push-back time from the parking gate to conform to traffic management restrictions, e.g., ESP conformance timing. This calculation enables traffic management conformance while sitting at the gate with engines off and thus reduces fuel burn and associated emissions.

Movement Area—The airport operational surface area (taxiways, runways, holding area, etc.) that is under positive ATC control and requires a clearance from ATC to enter.

Non-Movement Area—The airport operational area that is not controlled by ATC, usually the ramps leading up to and including the aircraft parking area.

OOOI—Out of parking, Off the ground, On the ground, In parking (pronounced "OOO-E") is a capability that provides four data points to measure and gauge the efficiency of aircraft ground movements. Avionics equipment on many airline and business aviation aircraft automatically reports these times to the operator via avionics, who in turn generally provides this report to the FAA.

SOBT—Scheduled Off Block Time is the original planned departure time from the parking position and is updated by the flight operator if variances occur. This time is used for long-range initial planning before the operator provides an EOBT.

TBFM—Time-Based Flow Management is the system that utilizes timing of air traffic to ensure the appropriate arrival demand at an airport. This technique can begin hundreds of miles from the arrival airport and includes display of sequence times to the various air traffic controllers so that when arrival streams merge, appropriate volume is generated and airborne holding is, in most cases, eliminated.

TMAT—Target Movement Area Entry Time is used primarily at busier airports where large sections of aircraft parking and movement ramps adjacent to parking positions are controlled by non-FAA entities. These operations are complex and include significant vehicle movements to support the operation, which could include obstructions to movement from the parking position in accordance with a time issued by the DRC. Thus instead of parking position movement times, a TMAT is issued. This is the time that the aircraft should be positioned ready to enter the Movement Area.

Data Source

The type of data required in ACDM comes from multiple sources and multiple types of technology. There is no one source for ACDM data because it requires collaboration from many to gauge and predict efficient aircraft movement. Table 3 displays the common source(s) of the various data points needed in ACDM.

Once the data point source has been determined, their use is shown in Table 4, in chronological order.

The development of data interchange formats and standards by the FAA and international organizations is a major area of work. Regardless of the details of the standard, it is widely expected that standardized data formats and specifications will be employed in the near future. Two of the contenders in this arena are the Aeronautical Information Exchange Model (AIXM) and Flight Information Exchange Model (FIXM).

Required Data

The traditional FAA/Industry CDM program requires the operators to provide a series of aircraft movement data points to gauge and measure air traffic movement. Beginning in 2015, the following data points will be added to the CDM Message Set and are directly related to some

Table 3. Data point elements and sources.

		Sources					
		FAA NEGS (SWIM)	Operator/ Pilot	DRC	Airport Ramp Tower	Airline Ops Center	FAA ATCT
Data Element	AOBT Actual Off Block Time		✓			✓	✓
	ASDE-X	✓					
	EOBT Estimated Off Block Time		✓		✓	✓	
	ESP Time En Route Spacing	✓					✓
	ETOT Estimated Taxi-Out Time			✓	✓		✓
	SOBT Scheduled Off Block Time		✓			✓	
	OOOI	✓	✓			✓	
	PDRC Time (test program to time releasing of departures)	✓		✓			✓
	TMAT Target Movement Area Time	✓		✓	✓		✓

Table 4. Data point uses.

Data Point	Usage
SOBT Scheduled Off Block Time	The time filed with the flight plan to indicate the initial planned departure from the parking area. The first time is to be used to estimate demand. This time could have great variance because it is usually submitted before operational variances occur.
EOBT Esimated Off Block Time	The updated earliest time that the flight will be available to depart from the parking area. This time is expected to be fairly accurate since it is generated much closer to the planned departure, and thus operational variances can be considered in formulating this time. This is the time the FAA will utilize to plan Time-Based Flow Management (TBFM).
AOBT Actual Off Block Time	Actual time the aircraft started movement from the parking area (part of the OOOI message set). Also detected at a few airports with surveillance.
ETOT Estimated Taxi-Out Time	The time estimated for the aircraft to move from the parking area to the runway for departure. This is used to calculate demand at the departure runway and to calculate an EOBT to the flight operator.
TMAT Target Movement Area Time	The time for the flight operator or ramp tower to position the aircraft for entry onto the Movement Area and transfer control to the ATCT. TMATs are utilized in areas of dense vehicle and aircraft movement ramp areas where timing for departure from the gate is impractical.

Note: ESP system times are utilized by the DRC to calculate the desired time the aircraft should be at the runway for departure to conform to these and other traffic management activities. The EOBT or TMAT are then calculated by subtracting the ETOT from the desired runway time.

possible ACDM programs. The standardization of this information sharing will be valuable in facilitating the creation of various ACDM programs going forward.

- Updated SOBT
- EOBT
- OOOI times
- Tail number of the aircraft—to match the intended flight with actual tail numbers to better gauge demand
- Intended parking gate/area
- Flight cancellation indicator

Security, Privacy, and Proprietary Information Considerations

As with any data, there are concerns about the usage and public availability of the data, especially real-time position information with rapid update rates. Thus the FAA/Industry CDM program requires real-time data or display access to have a degree of security where it is not available for public display. Additionally, traffic management timing (EOBT and SOBT) could cause confusion about boarding availability if it is available to the general public; therefore, the FAA/Industry CDM program information is not available to the general public, and many current CDM members believe that ACDM data should not be publicly available. The general concept of the FAA/Industry CDM program is that if you share information, you see all the information shared (unfiltered) from everyone who shares the same data. This provides a degree of accountability among all participants.

On October 8, 2014, the NextGen Advisory Committee formally recommended to the FAA that airports, if desired, have some type of FAA/Industry CDM program membership and/or access to CDM data. The recommendation has been accepted by the FAA/Industry CDM Steering Group for action and implementation. This recommendation will impact all ACDM data distribution and decisions in the future, so airport operators must be aware of the constraints and desires of flight operators and plan for data security and restrictions.

CHAPTER 3

Role of the Airport and Other CDM

Stakeholders in ACDM

This chapter describes advantages of ACDM and outlines the role of the airport operator. It also outlines the roles and actions of certain airport stakeholders within the scope of ACDM.

ACDM is a process to identify problems and build solutions through consensus planning, information sharing, and any needed information technology tools. While this Guidebook will concentrate on surface traffic management, other airport operational issues are also relevant. Figure 5 presents the FAA Surface Office's depiction of the pivotal role of airports.

The airport operator plays a critical role in developing and implementing ACDM programs. The airport may be the ACDM initiator and lead the effort, it may have a lead partnership role with a major user of the airport, or it may be the facilitator or collaborator as part of the effort. For instance, the PANYNJ assumed the lead role in New York. They initiated and coordinated regular meetings with all airport operators and the FAA, described the objectives, sought input, developed communication, collaborated on the development of procedures and metrics, contracted for a departure allocation system and operational people to staff system usage, and in general, facilitated all collaboration. At other airports in Atlanta, Memphis, and Dallas/Fort Worth, the airport has partnered with the major carrier and/or a research activity for ACDM-like operations. San Francisco International Airport asked the FAA and received the Airport Surface Surveillance Capability (ASSC) viewer data to help mitigate impact of a runway closure. They will then replicate the PANYNJ effort for the display and usage of this data to allocate departure operations.

The airport's role may also be determined by the density and complexity of operations at the airport. While many of the operational issues such as safety and mitigating environmental impacts are the same, there are some distinct differences. For example, concerns may vary depending on the levels of congestion experienced at different airports.

- Highly Congested Airport
  - Controlling departure queue length to reduce delays while aircraft engines are running
  - Degree of control needed in the Non-Movement Area with multiple vehicle operations from many different vendors
  - Airport staffed ramp towers or ramp control functions to control congested ramp traffic sequencing
- Uncongested Airport
  - Flight diversions from a congested airport
  - Airport passenger services provision (food, CBP, etc.) for late flights after normal operating hours
  - Service provision focus around a single large predominant operator

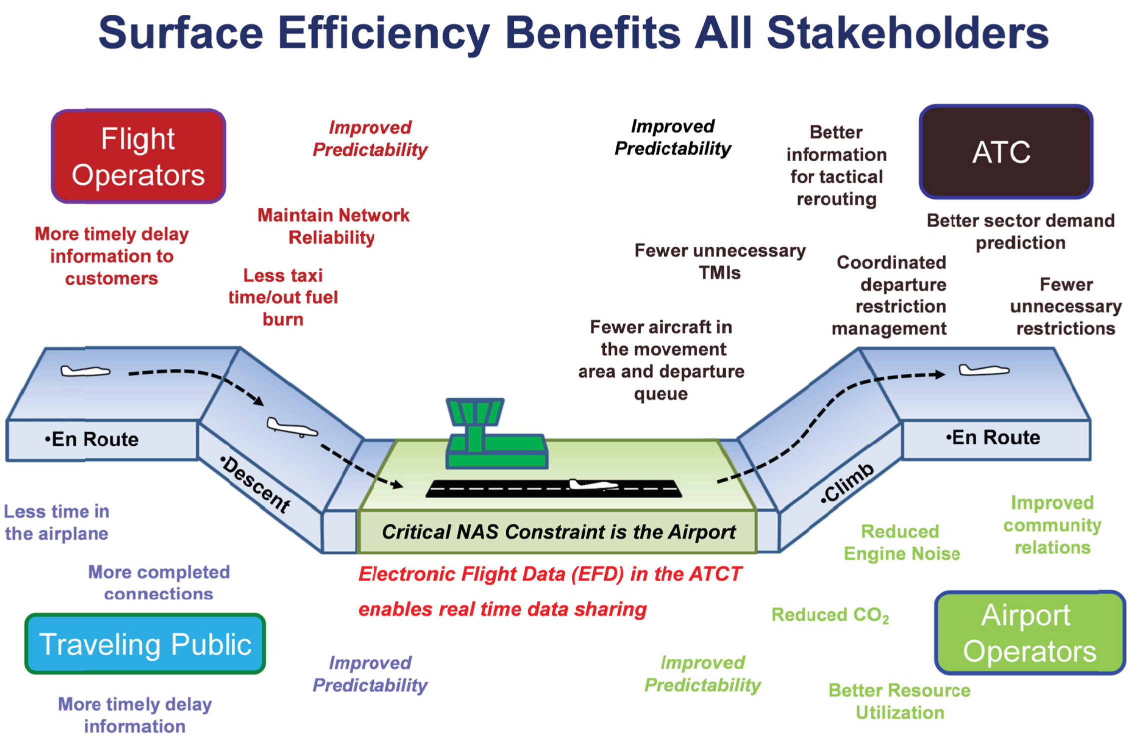


Figure 5. FAA Surface Office view of surface efficiency (FAA 2014b).

Determining applications for the ACDM process might be puzzling to airport operations with little or no ACDM experience. Table 5 is presented to assist airports and their stakeholders in determining whether conditions exist that could be addressed by ACDM applications. During airport interviews conducted in preparing this Guidebook, suboptimal conditions existed at some airports for the issues outlined herein.

Whatever the role, the airport is a key player because it provides the operational platform for all the activities. Once a potential need has been established, then the benefit-cost guidance

Table 5. Determining need for ACDM.

Potential Problem	Conditions for Potential Application
Departure metering	• How frequently does the airport expect to have more than 7 aircraft queued for departure at a single runway?
De-icing coordination	• Does aircraft de-ice capacity sometimes restrict the departure rate?
Diversion coordination	• Is the airport a frequent diversion receiver? • Is there a potential for those diversions to exceed some element of airport capacity? • Is the airport notified in a timely manner of flight diversions?
Customs staffing	• Are customs clearing times highly variable due to timing of international arrivals?
Irregular Operations (IROPS) coordination	• Are all the mechanisms in place to respond to, and to prevent, tarmac rule violations?
Real-time departure scheduling	• How often are flights metered over shared departure fixes or into nearby TBFM arrival streams with delays?
Terminal service	• Do late departures frequently arrive after normal operating hours? • Could vendors capture additional revenue from adjusting hours in those cases?
Safety	• Is taxi conformance monitoring an issue for the airport operator?
Passenger movement information	• Could airlines/airport make use of the TSA boarding pass scans?
Service vehicle monitoring	• Is there a significant amount of surface vehicle traffic? • Do these vehicles interfere with flight operations?
Passenger facilities	• Are passenger facilities (food, curbside, restrooms, etc.) frequently overloaded?

provided in Chapter 6 may be applied to estimate the economic value of a potential ACDM application.

ACDM Advantages and Efficiencies

There are many potential advantages and efficiencies to be realized through CDM-enabled programs, both to the airport operator as well as to its customers. While many ACDM benefits are realized by other parties, there are many advantages for the airport operator as well. A few of these are listed herein. These, and others, are discussed in more detail in Chapter 6, including descriptions of how to conduct a thorough comparison of these against the potential costs of undertaking ACDM action.

- Brand enhancement—A more efficient airport may generate more passengers and additional flights, both of which generate airport revenue. This brand enhancement was noted as of particular importance in several airport interviews conducted under this project's research.
- Real-time diversion notification—If airports are afforded access to FAA/Industry CDM information, real-time notice of airline diversions can be gained through the Aggregate Demand List (ADL) or Diversion Recovery CDM pages. Thus, airports have immediate notification of actual flight diversions and more time to plan for these operations.
- Environmental benefits from the reduced emissions—Shorter taxi queues result in less fuel burned and decreased emissions, as well as potential noise reduction.
- Improved operational data—Data is available from several sources to completely analyze the entire surface movement history of a flight for post-event analysis, thus identifying possible changes to increase efficiency and safety.
- Scheduling and service improvements—With real-time estimated arrival times, airports could forecast well in advance demand for passenger services, CBP, baggage, food services, etc. The status and number of late flights could be relayed to airport concessionaires.
- Construction mitigation planning—History has shown that the planned mitigation for a number of construction projects has been altered and improved by collaborative inclusion of the operator preferences.

One of the primary future ACDM applications at congested airports, departure metering, enables many operational improvements beneficial to many stakeholders in runway departure queue efficiency. This yields the following results:

- A reduced number of aircraft waiting in the active Movement Area for departure with engines running reduces fuel burn.
- Controlled departure times are determined while at the gate and thus eliminate "penalty box" waiting for a controlled departure time. Some congested airports may not be able to utilize this attribute due to gate availability issues for succeeding flights.
- Controlling the sequence of flights in departure queues enhances the capture of all potential runway capacity to account for divergent headings; airspace constraints (e.g., Miles in Trail); and optimized sequence with respect to aircraft wake vortex category.
- Reduced congestion and workload for the ground controller enhances efficiency and safety.

At relatively uncongested airports, one of the prime considerations is departure readiness prediction to enable more efficient operations to merge into major traffic flows or streams. For example, smaller airports generated many short-range flights into congested airports. The congested airport arrival traffic is time-based metered by the FAA. Time-based metering results in each flight being assigned a metering time to provide a smooth constant flow of arrival traffic. Short-range flights are the last to call for metering times, and thus metering time availability is limited, which results in the departure being held on the origin taxiway for its metering time.

If accurate flight departure readiness predictions could be made 30–60 minutes in advance, metering time requests could be made earlier, which could result in delay absorption at the gate before passengers board the aircraft, and in some cases, can reduce the amount of delay required.

Other ACDM applications may also help to enhance future airport planning and development efforts, which usually result in construction activity. Some of the most beneficial ACDM-type activities have helped to mitigate construction impact in New York, Atlanta, Memphis, and other locations. In New York, departures were metered to control runway queues, and in Atlanta and Memphis, construction vehicle traffic across active taxiways or ramps was controlled and metered to ensure safety around taxiing aircraft.

Any ACDM effort will inevitably involve data sharing. If the appropriate data are shared in such a way as to allow straightforward means of access in specific locations (e.g., an airport-operated ramp tower), operational performance should be improved. Using the San Francisco International Airport major runway construction in 2014 as an example, the FAA in collaboration with many stakeholders provided an ACDM-type data sharing feed via the System Wide Information Management (SWIM) system to aid in situational awareness and controlling departure queues. As with the FAA/Industry CDM program, the FAA did not provide the software to display the data; it only provided the data.

Additionally, ACDM data sharing results in post-operational analysis. Having a better understanding and record of both typical and unusual operational trends will enable better planning. Better planning will result in improved operational predictability.

Finally, several airports and airlines operate or contract ramp control towers. These facilities were originally established to better control the vehicle and aircraft movement activities in the Non-Movement Area. But their scope and responsibility has expanded to include, in some cases, major portions of the airport surface, including staging departures in a more efficient sequence, i.e., United Airlines Ramp Tower at Newark Liberty Airport. The gate-to-gate concept long advocated by EUROCONTROL and the similar concept envisioned by the FAA TFDM program will certainly utilize both ramp towers and operational control centers to effect these concepts.

Airport Operator Role in ACDM

Airport operators are in a unique position to foster, support, or lead ACDM implementation efforts because they have established relationships with every party operating at the facility. In broad terms, their primary role is to lead, partner/co-sponsor, or support the establishment of various ACDM-related activities and to act as the liaison to coordinate ACDM activities between the various operators, vendors, and other involved parties. If the airport operator is not directly involved, then application of ACDM concepts will struggle. In coordinating these efforts, they must ensure that all relevant parties are able to participate and thus have their perspective included. This does not imply that airport operators must, or should, control all aspects of an ACDM-related program since much of the value of these programs is derived from their collaborative nature. However, since airport operators are the most connected parties, they have the greatest ability and more potential avenues by which to enable participation, which will breed success.

Thus, ACDM is not a one-size-fits-all proposition, and not all airports will benefit in an equal manner from their involvement. During airport interviews in preparation of this Guidebook, a wide range of operational problems were encountered both at highly congested and less-congested airports. Some airports had long departure queues, other airports were concerned about a potential for runway incursions from a large number of aircraft towing operations, other airports have the likely potential for diversions from a busy airport, and others had major airport construction projects. ACDM knowledge, however, is important to all airport operators because at some point, issues may arise that can be solved or improved using ACDM processes.

Perhaps the underlying principle to success in ACDM for the airport operator is to meet with the program participants regularly, frequently, and productively. Current ACDM experience has indicated that frequent meetings are the most critical component for a successful program. As the lead/co-lead/partner/facilitator/coordinator, the airport operator must ensure that these meetings take place and have the inclusion that breeds success. In 2010, when the PANYNJ was considering the establishment of the ground departure metering function to mitigate impact of runway reconstruction in an ACDM process, they inquired of European ACDM participants for best practices. The first response received by the PANYNJ was "to meet, meet again, and meet some more." The inclusion in the ACDM concept is not immediately realized or accepted by all parties, and frequent meetings will help to facilitate this realization.

Some congested airports, at which significant departure queuing exists, will want to establish departure metering programs to control the size of these queues through FAA programs or other means. While several approaches for implementing these systems currently exist, the airport operator lies at the center of each, given their implicit, and in some cases, explicit control over the Non-Movement Areas of the airport. In many of these concepts, and the one system currently used in practice in the United States, the airport operator is responsible for providing the DRC functions. This includes installation of the automation that collects operator readiness data and distributes the assigned metering times for departing the aircraft parking area. They also coordinate between all flight operators to ensure that the system is operating effectively and efficiently, obtaining this feedback through regular and frequent meetings. It should be noted that airports performing the DRC function might be the exception rather than the rule because it is expected that the FAA ATCT will usually perform this function. But the FAA TFDM program recognizes the importance of this DRC function, and, while it will be an FAA function at many airports, the FAA is establishing criteria for the DRC to be an airport or major airline function at other locations.

As stated, inclusion of all participants, no matter how small the role, is key. A checklist of potential ACDM participants is provided herein. It is unlikely that any individual airport would have every one of these participants due to local variations in operations, procedures, and regulations or would need to include each in any given ACDM activity. As a result, use this list as a starting point for parties to consider for inclusion in ACDM discussions and planning. A worksheet is also provided in Appendix B.

1. Flight Operators
    a. Passenger airlines with scheduled service, including both mainline and regional operators
    b. Other passenger carriers, if they have regional presence but no mainline operations—for example, if United only serves the airport through United Express operated by SkyWest, it may still be helpful to include United mainline personnel
    c. Passenger airlines with regular charter service
    d. Cargo airlines with scheduled service
    e. Other cargo carriers, if they have regional but no mainline presence
    f. Cargo airlines with regular ad hoc service
    g. Military representatives from appropriate branches
    h. Recreational general aviation representatives
    i. Business jet operators with regular service
    j. Flight training providers
    k. Local/state government operators, including law enforcement and Medivac
    l. Unmanned aircraft systems operators
2. Airside Service Providers
    a. Fixed based operators (FBOs)
    b. Fueling contractors

   c. De-ice contractors
   d. Catering providers
3. Ramp Service Providers
   a. Contract aircraft maintenance providers
   b. Aircraft manufacturers
   c. Snow removal providers
4. Official Services
   a. Local, state, and federal law enforcement agencies
   b. Private security contractors
   c. Transportation Security Administration (TSA)
   d. U.S. Customs and Border Protection (CBP)
   e. Environmental/wildlife agencies
   f. National Oceanic and Atmospheric Administration (NOAA)/National Weather Service (NWS)
5. Services Commonly Provided by Airport Operators
   a. Airport Rescue and Fire Fighting (ARFF)
   b. Facilities Maintenance
   c. Planning
   d. Engineering
   e. Operations
   f. Administration (Finance, Contracts, Marketing, Business Development)
6. Operational Control
   a. Ramp Control Tower
   b. Local ATCT, including military equivalent
   c. Local Terminal Radar Approach Control (TRACON) facility, including military equivalent
   d. Local Air Route Traffic Control Center
   e. Adjacent spaceport or range operators
7. Landside Service Providers
   a. Commercial ground transportation—taxi, shuttle, limousine, bus, etc.
   b. Public transit—rail, bus, etc.
   c. Food service
   d. Retail
   e. Airport hotel
   f. Janitorial
   g. Rental cars—on and off airport
   h. Parking lots—on and off airport, both airport- and privately operated
8. Community Stakeholders
   a. Local government authorities
   b. Local environmental organizations
   c. Community Part 150 regulations
   d. Information programs for surrounding communities

Role of Airport Stakeholders

Scheduled Passenger Carriers and CDM Flight Operators

Scheduled passenger carriers play a significant operational role at many airports. As such, they are an important participant to be included and sometimes lead or co-lead an ACDM effort. Furthermore, they provide the interface to the largest contingent of airport customers—passengers. Thus, facilitating smoother operations for these carriers may go the furthest in helping to enhance the airport's brand with this important contingent. Additionally, CDM flight operators have the greatest access to real-time operational information and also have been participating in CDM related activities for years. This segment can be a valuable source of expertise to an airport by providing examples seen at other airports such as:

- Lessons learned from other CDM projects
- Construction mitigation techniques used at other airports
- Sources, uses, and integration of aircraft movement data
- Source and generator of needed real-time operational data

For example, to reduce taxi queue length in a departure metering program, departure readiness predictions prior to push-back is a key ingredient. Other examples are initiating ramp push backs timing to influence taxiway sequencing to promote the most efficient departure sequence to mitigate wake vortex separation requirements, and initiating ramp push-back timing to transparently promote airline business case departure preferences. Scheduled passenger carriers and participating business aviation operations at an FBO play a critical role in providing data on the expected readiness of each of their flights. Flight readiness allows for better planning and control of departure taxi queues.

To enable flight readiness predictions, the FAA/Industry CDM community has agreed that in 2015 CDM participants will furnish an EOBT, making flight departure readiness prediction information available for CDM participants. For the locations with complex and busy ramp areas, the EOBT message could be taken into consideration in assigning a TMAT for which the flight is expected by ATC to enter the Movement Area. These ramps have considerable vehicle traffic, and for ATC to enact control times from gates may not be feasible, so the TMAT time was established to promote conformance. While departure metering may not be a direct airport function, departure readiness will be influenced by airport and airport vendor activities, e.g., catering, de-icing, aircraft towing, gate management, ramp tower instructions, and construction.

A sample checklist for each scheduled passenger carrier and flight operator is provided in Table 6. This list is intended to be exhaustive; it is unlikely that any individual operator would require each of these issues due to local variations in operations, procedures, and regulations. It may be useful for the airport operator to consider these issues in framing participant interactions and to provide to participants as a starting point for issues to be considered in their operation.

Table 6. Scheduled airline and flight operator checklist.

Checklist Questions
• Does the proposed effort impact my operation in any way?
• What are the benefits of the proposed effort?
• What are the potential costs to the company of the proposed effort?
• Does the company participate in any similar ACDM programs at other airports?
• Is there any institutional wisdom that may inform the company's participation in this effort as a result of previous ones?
• What demands will be placed on local staff to participate?
• What demands will be placed on other company staff to participate?
• If the company is required to communicate data, what effort is required to compute this data? Who will be responsible for this effort? Does the company possess any automation to support this task? What effort is involved in communicating these data elements? Are these communication means familiar to company personnel?

Non-Terminal Services and Functions (Fixed Based Operators, Aircraft Industry, Military Areas, etc.)

At present, general aviation, except for NBAA participants, and military are not direct FAA/Industry CDM program participants and therefore will not initially participate in the EOBT message set in 2015. That does not mean that they are excluded from ACDM. To the contrary, ACDM will introduce and enhance their knowledge of programs like departure metering with their inclusion at meetings and frequently will generate volunteer activity to join the process.

Operations in this area are diverse. For example, military procedures and operational needs are likely quite different from cargo carriers. Likewise, recreational general aviation operators may be quite different from corporate flight operators. Additionally, large aircraft industry operations will have different needs. For example, an aircraft manufacturing plant that is located at an airport conducts a large number of movements each day involving aircraft towing operations from one point on the airport to another. While their operation is responsible for a large percentage of this type of operation, their planning and experience may be very valuable to an operator that performs this function only occasionally. ACDM is all-inclusive. The airport is a community of flight operators, and the entire community should have a role in or can learn from shaping the ACDM effort. This inclusion is particularly important early on in the development of a program because operators in this category will have the least experience or knowledge concerning the ACDM process, and early inclusion will reduce the learning curve.

Terminal Services

A variety of stakeholders providing service operate in passenger terminals, and some of these may have an interest or a role in a given ACDM activity. This category of airport stakeholder may include essential security services like TSA, CBP, and law enforcement. Other stakeholders that provide terminal services would include those that provide passenger conveniences like food service and retail, along with those that provide airline functions like gate agents and lounges. Improved data sharing could potentially enhance all of these stakeholder functions. For example, if the passenger count from inbound international flights was correlated with a real-time estimated time of arrival, a highly accurate demand on CBP functions could then be forecast in advance. Another example is food and service vendors for late flights. If vendors had a process to receive predictions of real-time day-of-operations arrival and departure data, then they might tie their operating hours to this data. Thus service to passengers would be enhanced. Such parties should always be included when ACDM efforts have the potential to impact or alter their operations.

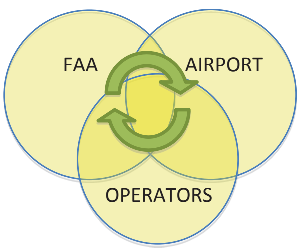
It is important for the airport operator to consider, however, that these organizations will have different objectives and potentially significant constraints on their ability to modify operations in response to ACDM activities. However, as they provide essential contributions to the passenger experience, they are an excellent area in which the airport operator may try to improve the overall operation.

Landside Services and Operations

Landside operators, including parking providers, rental car operators, public transit, and other non-transportation functions, may also have a role to play in ACDM efforts. For example, improved data sharing mechanisms may help these service providers to identify schedule disruptions earlier and provide much-needed services outside of their normal operating schedules. Many of the same considerations were described in the previous section; much of the benefit to be realized by and through these parties relates to schedule and modifications thereto.

CHAPTER 4

Implementing CDM at Airports



To implement ACDM either as a leader or partner, airports will be required to commit financial and staff resources to the effort. ACDM is also a process that may require expanded communications and enhanced communications/outreach programs. Thus, it is desirable for the airport to assign specific staff to lead and track ACDM activities.

During the implementation of ACDM it is important that airport staff understands management's goals and objectives and the airport's commitment to ACDM. Not unlike most complex programs and efforts, such as the implementation of Safety Management Systems (SMSs), ACDM is a change in the way airports do business and will require staff training to assure effectiveness. In other words, airport staff will need to be trained on ACDM background and procedures before it can successfully be deployed.

This chapter covers the phases of implementing ACDM. The initial ACDM implementation should address a single project or idea. Because forecasting the benefits and understanding the costs of a potential project are so critical to its success, they are treated separately in Chapter 6. This allows scalability of the effort, promotes learning and proper techniques, and in general, allows ACDM implementation with minimal interference to normal job function. Appendix B provides worksheets for ACDM implementation.

Problem Identification

Implementation of ACDM begins when an operational problem or issue is identified; ACDM can also be used to address problems proactively, i.e., before they exist. For example, hazmat or security issues are addressed much more effectively when a plan exists to address such issues. Diversion recovery and notification can be planned in the same manner.

Step One. The airport work unit responsible for implementing ACDM identifies the issue(s) that could potentially arise and that ACDM could address. This list of issues will help identify which stakeholders need to be included in the ACDM process, (see Appendix B for a checklist). When developing the list of participants, everyone who could possibly be impacted should be included. The following are real-life examples of the need for ACDM-type inclusion.

- An airport desired to implement Area Navigation (RNAV) Standard Instrument Departures (SIDs). They established an operational technical group that included air traffic controllers, pilots, avionics experts, etc., to develop the procedures. The implementation group did not include extensive community outreach beyond those noise-sensitive communities immediately adjacent to the airport. The procedures would change the aircraft flight tracks, so additional communities not adjacent to the airport were, for the first time, going to experience aircraft flying over their communities. Even though the noise generated by the new flight tracks was considerably below any threshold, the lack of information to these communities created problems.

- An airport planned for complete reconstruction for a runway and parallel taxiway that would result in significantly reduced airport capacity for a lengthy period of time. The airport held a meeting with all airport stakeholders and ATC. During this meeting an attendee suggested that the taxiway be rebuilt first and that it be rebuilt to a runway standard where smaller aircraft could utilize it for arrivals and departures while the main runway was closed. The idea was researched and adopted, thus mitigating a considerable portion of the reduced capacity.
- An airport planned to rebuild a runway. The only access to this runway was across active taxiways, which meant that construction vehicles would require access across the active taxiways. The construction contractor and airport operator developed a method to utilize the active taxiways in a specific manner that included identifying flights with color coding so that the vehicle control point knew when to safely cross the active taxiway.

As part of the problem identification, ACDM meetings should be held to ensure complete problem identification and inclusion of all appropriate stakeholders. From past ACDM-like implementations and trials, including European ACDM, the two most important factors are meeting regularly and inclusion of all potentially affected parties. When the PANYNJ implemented their departure metering control at JFK, they sought advice from ACDM participants both in the United States and Europe. Further information on the details of the JFK implementation is available in Appendix C. The advice given was to "meet, meet again, and meet some more." The best plans include all viewpoints. Meetings also ensure peer pressure accountability for conformance to the plan.

The introductory steps are as follows:

1. Identify the issue or planning desired and the impact.
2. Identify relevant stakeholders, hold an informational meeting to state the problem(s), and gather input from all stakeholders. A thorough record of participation should be kept (see Appendix B).
3. Make sure that the meeting is all-inclusive.

Developing the ACDM Approach

Step Two. Identify what historical and real-time data information is needed to develop and implement the plan. For example, the FAA/Industry CDM program participants determined that certain information was needed to address the issue at hand. The participants identified the information needed and worked together to provide that information, and the leadership of the group was not solely responsible for procuring the information. Then tools were developed to efficiently present that information in a useful manner. The ACDM participants could use many of the capabilities of tools developed by the FAA/Industry CDM program. All major operators at an airport plus NBAA are FAA/Industry CDM members and thus have knowledge of these tools and their function. Using these experienced resources that have knowledge concerning these capabilities is a valuable asset to the ACDM community.

Some examples of relevant tools or collaboration mechanisms are listed herein. The actual name of the tool is only listed for reference; it is the capability of the tool that is relevant.

1. Traditional CDM Tools
   a. Flight Schedule Monitor (FSM) (to depict real-time airport demand and delay data)
   b. Diversion Recovery Page (for illustrating diversion information)
   c. CTOP (to view routing options for least delay)

   d. Aircraft Situation Display for Industry (ASDI) (a real-time display of active flight position to enhance situational awareness)
   e. Aggregate Demand List (ADL) (to provide real-time lists of arrival and departure demand that reflects all amendments by users and FAA ATC entities).
2. FAA Tools
   a. The FAA is distributing the Volpe Surface Viewer to several airport ATC facilities. This viewer displays the real-time position of all aircraft on the airport Movement Area. It is intended for air traffic only, but may possibly be made available in the future.
   b. Airports that can obtain access to CDM tools or SWIM can and have contracted and created another avenue to provide situational awareness with a surface viewer to operational entities at an airport. Figure 6 depicts the site locations where surface surveillance of Movement Area and some adjacent Non-Movement Area is available via SWIM as of May 2014.
   c. The FAA has an extensive series of preferred departure routes from a busy metropolitan area. In New York, the local airport users association obtained these routes from the FAA and distributed these routes to their users, thereby greatly increasing route conformance when flight planning.
   d. For airports that operate or have contract ramp towers, FAA traffic management restrictions would be an asset in determining movement priority in order to complement the ATCT operation.
3. Weather Tools
   a. Integrated Weather System (ITWS) is a tool that combines several weather products into an airport area display that depicts severe weather location, direction, and speed of movement.

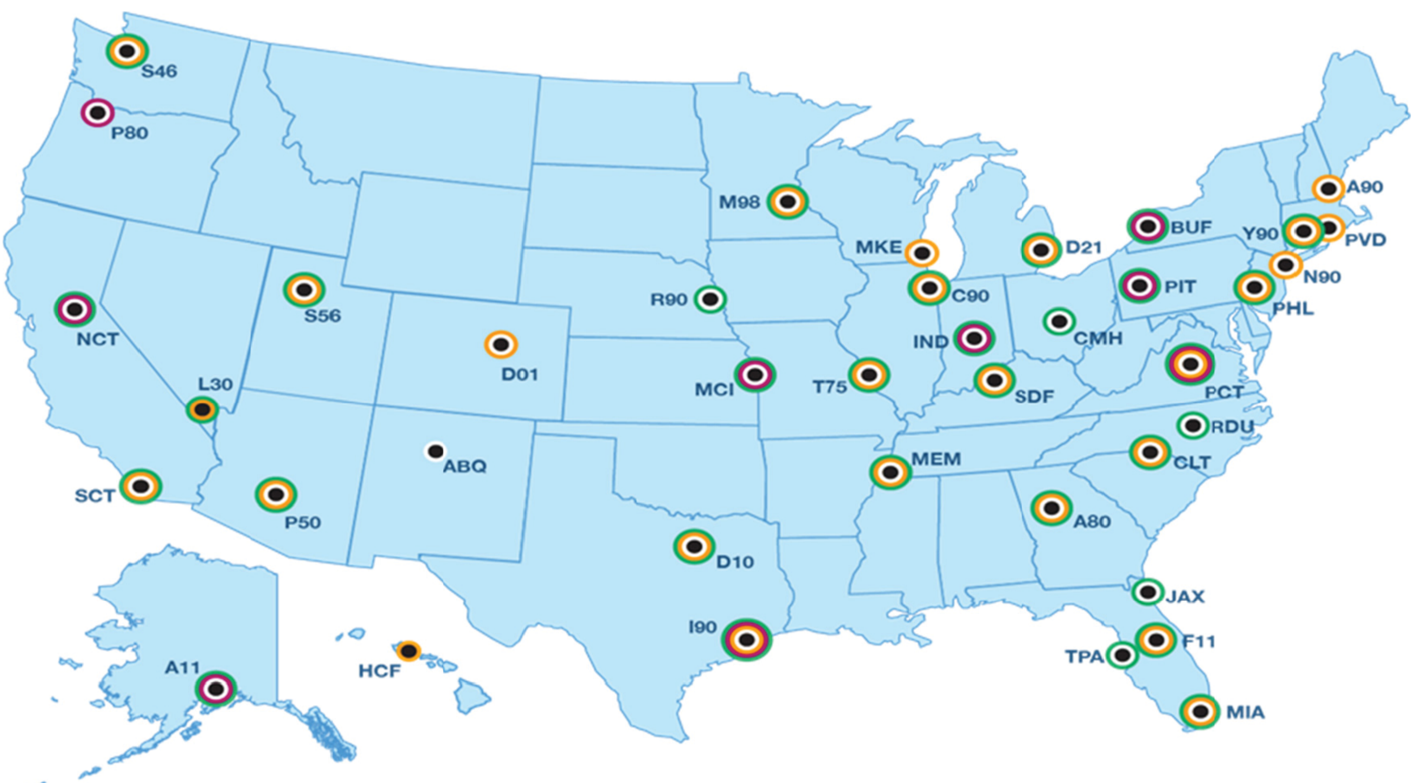


Figure 6. FAA surface surveillance locations available via SWIM (FAA 2014b).

   b. Low Level Wind Shear Advisory System (LLWAS) detects wind shear around the airport with multiple sensors.
   c. Corridor Integrated Weather System (CIWS) combines several ITWS outputs into a single display for a broad geographic area view of severe weather.
   d. Lightning Detection
4. Regional Tools and Concepts
   a. SEADOG (Southeast Airports Disaster Operations Group) and WESTDOG (Western Airports Disaster Operations Group) are collaborations of regional airports to coordinate fast responses to specific operational and logistical needs such as flight diversion alerts, hurricanes, and associated storm activity.
5. Mechanisms for Data Exchange
   a. SWIM/FAA Tech Center is used to promote collaboration the FAA has established with SWIM and distributes it through the National Enterprise Gateway System (NEGS). An airport would make application for access via the NEGS on FAA Form 1200-5, NAS Data Release Request.
   b. AOCnet (Airline Operations Center CDM Network) is the CDM network that distributes the FAA/Industry CDM Tools listed in item #1. It is only available to CDM members, but as noted herein may become available to airports.

While access to these tools and their information may be currently restricted, there are exceptions to these restrictions, and participants in ACDM, especially the flight operators and ATC, may be able to facilitate these exceptions. The RTCA NextGen Implementation Surface workgroup, an important FAA/Industry advisory panel, formulated a recommendation to share CDM and FAA traffic management data with airport operational entities. This recommendation was approved by the NextGen Advisory Committee, and the FAA accepted it and is in the process of enacting this recommendation. The National Traffic Management Log has been made available via the System Wide Information Management (SWIM) system. Time-based Flow Management data access via SWIM is being tested with one flight operator, and the FAA is taking action to allow airports to join the FAA/Industry CDM Program.

ACDM Implementation

Step Three. Execute the plan, including the identification of each organization and their responsibilities, the existing facilities, data and infrastructure identification, such as automated decision support, and plan execution. At this point, all ideas have been discussed by the ACDM group and those that the ACDM group identified as having merit are defined in writing. This written plan should document the following steps:

1. Develop the problem statement and solution.
2. Identify the information/data or support tools needed to implement. This includes data security since some may be proprietary.
3. Determine the cost of implementation and available funding.
4. Determine whether a formal business case (i.e., monetized benefit-cost analysis) is warranted, and if so, conduct it (refer to Chapter 6 for more details).
5. Detail the risk and cost of maintaining the status quo (doing nothing).
6. Give the stakeholders assignments to complete the plan.
7. Develop the training required to enact the plan.
8. Identify and capture the metrics to measure success.
9. Stakeholders brief their management and gain buy-in. Frequently, a stakeholder ACDM participant will be required to coordinate with other functions within that stakeholder. For example, a stakeholder from air operations might have to coordinate with a vendor that provides contract services to that individual stakeholder.

When considering ACDM implementation and the development of this plan, two of the areas mentioned require careful consideration.

- The first issue is that data is required in order to be measured and make the stakeholders aware of the issues, but some of that data may be proprietary and/or sensitive. Due to the sensitivity of the data, the ACDM group must understand that issue and, if needed, afford protections. For example, a large airport construction project might indicate degrees of delays in ACDM meetings. The airlines serving this airport might want to protect the delay data so as not to alarm passengers to the extent that they seek alternate routes to avoid the initially forecasted delays.
- The second issue that the ACDM group needs to carefully consider is appropriate training. Proper training should be part of any plan. For example, anything involving aircraft movement will involve the pilot of the aircraft. Communication and/or training may take place through flight data charts or Electronic Flight Bag (EFB) displays. A common chart or display among all pilots, collaboratively developed by the ACDM group, will benefit the actual application, so operators should want to collaborate on this type of training.

All of the steps require a comprehensive effort since the desire of ACDM is all-inclusive participation. To focus on specific issues, sub-groups may be formed. The airport will frequently not lead or even attend the sub-group meetings, but their work is reported to the general meetings. Inclusion, participation, and accountability are the key words in these steps.

Establishment and frequent reporting of key metrics or deviations from plans is critical. Participation and accountability are gained by openly reporting individual entity compliance. Reporting should be factual and actionable. The lack of compliance may not be known by the entity involved, and they cannot fix what they do not know is broken. For example, during a construction period at a particular airport, a set aircraft taxi route was established. An operator thought he had publicized this taxi route to his pilots, but the distribution method partially failed internally. After data reporting indicated this lack of compliance with quick transmission to the operator, the operator was able to quickly identify the problem and correct it.

Finally, from this effort emerges the comprehensive and complete plan to address the issue originally identified. Meetings ensure individual accountability during the project. Metrics broadcast to the group indicate the degree of ACDM group success, not individual function ranking. Group problem solving, group acceptance and compliance, and group review of feedback and data reporting all lead to successful ACDM.

Developing the ACDM plan or solving a single problem is not the end of the ACDM process. Continued review of the process is required to sustain CDM/ACDM as a dynamic tool for problem solving. Measured success or even failure should be carried forward to the next project so that all new projects do not require starting from zero.

Past successes in the traditional FAA/Industry CDM program have shown that success leads to a need to organize the processes to ensure continuity and to promote participation for future projects. This is accomplished by meeting even when there is no large problem to solve. Continued meetings ensure ongoing relationships. A vehicle to bring forth ideas is a valuable commodity in itself. Regular monthly or quarterly meetings among all airport tenants, not just major tenants, take place at some airports today and have shown great benefit.

Scalability in Size and Scope

Since ACDM will be a new concept to many airport stakeholders, initial ACDM applications at an airport should be limited in scope and size. This will allow a more gradual implementation, which will ease stakeholder apprehension and allow learning and application of ACDM to take place at an acceptable pace.

ACDM might also be a part of a larger project at the airport, thus limiting initial ACDM efforts to a specific project or idea to help ensure success. As previously noted, the PANYNJ developed departure metering to control taxi queues using ACDM techniques that were actually part of a much larger construction project to rebuild a runway. Scalability allows introduction of ACDM techniques in a controlled manner while participants learn how the program works and the benefits derived by using ACDM practices.

Technology and Interoperability

The FAA/Industry CDM program has developed processes for efficiency and capturing capacity. Technology facilitates this process. ACDM is a process that uses technology to facilitate information distribution and plan enactment and to create common situational awareness. While certain technology may be needed, the process to use and define the technology is more important.

Some airports have utilized existing technology as they begin the development and implementation of ACDM. For example, FIDs present needed passenger information such as departure gate and times. Some airports use extended fields on the FIDs that are only viewable to operational entities on a need-to-know basis.

Interoperability is just as important. As previously discussed, flight operators' operations centers are not usually on the airport. These operations centers are not focused on one airport, but rather their entire system; therefore, common operating systems are desired, which is one reason that web pages, which minimize interoperability issues, make an excellent choice. Still, a Security Operations Center (SOC) does not want to deal with a large number of airport-specific web pages. Ideally, standards can be developed and data shared through the operations center internal tools in cases where a widely experienced problem is being addressed.

CDM/ACDM Information and Updates

One of the attributes of ACDM is that it is a constantly evolving process, adapting itself to the needs of the participants, new tools, and concepts. Thus, the FAA maintains a web site for CDM information. Airport staff can obtain updates from all types of CDM activities from the CDM web site http://cdm.fly.faa.gov/.

Additionally there is a CDM email list for meetings and major events. This list is referred to as the "CDM exploder." The CDM web site listed above contains the contact information for the designated FAA CDM official who can supply contact information for work groups, the exploder, and meeting/event information.

CHAPTER 5

Challenges and Limitations to Implementation

After describing the background and general processes for implementing a project at an airport using the ACDM process, it is important to acknowledge and discuss the myriad challenges that may be encountered in such a project. Some of these challenges and limitations have been encountered in the FAA/Industry CDM program; others have been encountered in actual field trials, while others are a result of the ACDM activity in Europe. These challenges and differences will vary from airport to airport.

Lessons Learned

There have been some significant examples where collaboration was not fully accomplished:

- In May 2009, flight departures at a major airport in the northeast were restricted due to weather. This restriction was not communicated, and more than 70 aircraft taxied out, resulting in aircraft holding in departure queues on taxiways for hours.
- During the winter of 2011, a snowstorm at a major airport in the northeast caused multiple flight diversions to another regional airport. The regional airport was unable to accommodate the unexpected flight diversions. Passengers were held in aircraft on taxiways for hours.
- In 2011, arrival flights at a major airport on the East Coast could not access an offloading gate because all ramp space was occupied by weather-delayed departure flights.
- During the summer of 2013, an airport in the southwest received unexpected flight diversions due to severe weather at their original destination. These diversions were generated by two different airlines. The airport did not have the facilities to promptly refuel these flights, causing lengthy delays.

The first obvious lesson is the difference in airports that ACDM must accommodate. Every airport is different in type of operations, runway layout, seasonal weather types, unique terminal and parking position layout, density of operations, type and number of ramp tower operations, and multiple other differences. These local differences negate the effort for one standard ACDM operation among airports. Every airport has its individual needs, and these needs must be reflected in that airport's ACDM program. Both U.S. ACDM and European ACDM efforts have encountered these differences. For example, each significant flight operator in the United States has some type of control center. These centers have a great deal of connectivity and collaborate in a centralized traffic management arena with the FAA ATCSCC and each other through the FAA/Industry CDM network. But they do not usually cooperate with each other on the airport level managing taxi queues and coordinating push-back. In Europe, the problem is the reverse, with the significant number of different ATC service providers usually airport-centric. There are some issues that are not obvious at the start but generally are encountered later:

- Information sharing has to enable access to remotely located operations centers for airline, business aviation, and military operators.
- Airline business case objectives are different. A hub and spoke carrier will have different needs than a point-to-point carrier.
- Not all flights of the same carrier carry the same priority. The same airline might have different objectives for different flights for reasons that are unknown to every other stakeholder.
- Open-mindedness is key. Unusual concepts that are not generally practiced can produce significant benefits. For example, airport and airline personnel working side-by-side in the same control facility can produce an effective workspace. Additionally, it can be expected that different levels of participation might exist but usually are mitigated as the process matures and positive results experienced.

IT Support/Integration

Airports enabling ACDM concepts usually encounter the need to integrate information. Sometimes historical local formats for systems such as FIDs seemingly dictate formats to be used. Standard aeronautical data formats, such as AIXM and FIXM, should be utilized since flight operator operations centers will need to accept formats from multiple airports, and standard formats facilitate this process. Additionally, IT updates and the timing of such updates to systems used by more than one stakeholder require collaboration. Issues in this area are as follows:

- Several individual airports have developed and installed "individual" airport systems of integrating flight data and ground tracking of aircraft. There is usually little coordination between airports to make these various systems uniform, so the flight operators are seeing the need to adapt to several different systems when they want real-time information from different airports.
- The "individual" airport systems mentioned in the prior bullet are usually displayed on the computers of each individual flight operator. For optimum conformance in the airport system, each computer should be running the same version of software or known compatible versions. Thus the timing of the updating of these operator computers needs to be coordinated. This attribute may appear obvious but should not be underestimated. At an airport in the southern United States, construction data was being shared via PDF files. Some users updated their PDF reader and were able to read the files, while others did not and were not able to read the files.
- Some airports simplify technology issues by using web pages. Most airports have restricted access web pages where ACDM information can be distributed. The use of this distribution method should be minimized wherever possible because operator operations center communication might be inhibited by a large number of web pages to be accessed by several different airports.

Trust between CDM Entities

When the FAA/Industry CDM effort was established in the mid-1990s, information sharing was a new concept, and trust issues surfaced. The flight operators thought that universally exchanged delay data would be used by a competitor to illustrate their shortfalls in a public manner in order to gain market share. These trust issues resulted in some flight identification information being coded or scrambled so that a particular operator could only display the flight identifications of their operations. This complicated the quality assurance process because it required a central authority to unscramble all the data and interpret the results. Eventually, these trust issues were overcome once the stakeholders became aware of the benefits received from collaboration, and the data was unscrambled. Once the data was unscrambled, operators were held more accountable due to the fact that everyone was monitoring the same data, and thus collaboration actually increased. Positive collaboration leads to more collaboration. This was proven once again in the JFK airport departure metering initiative where originally conformance data was restricted to each individual operator. Once data indicating the degree of conformance was shared among all operators, conformance increased.

It should be expected that when implementing ACDM, some trust issues will arise. This may be especially true where one large carrier is predominant at a particular airport. For example, this was true in the original early CDM and was overcome by the Ration by Schedule (RBS) concept, as detailed in the next section.

Collaboration Barriers

Collaboration barriers will always exist. Participants have different viewpoints and/or business objectives. For example, NBAA is a major participant in FAA/Industry CDM programs. But this association represents a number of different companies, some of whom do not desire, for competitive reasons, their company aircraft flight origin and destination information to be made public. A CDM workgroup developed the concept that individual aircraft owners could request that their data be masked. The data was included in all demand lists, but the actual aircraft identification associated with that flight data was masked to the CDM community. Below are some collaboration barriers that are being discussed in the CDM community.

- At an airport where demand exceeds capacity, how should the capacity be distributed among the demand? In the CDM arena, this was solved by the technique called RBS. In short, for scheduled carriers, RBS demands that the rationing of capacity is based on the original schedule of operations, not the current projections of demand. Because the schedule is fixed and published well in advance, the consequences of operational decisions do not affect the allocation, allowing operators to focus on making the right decisions for efficiency rather than attempting to game the system. Research is ongoing to determine suitable priority for non-scheduled operators.
- How do we compute flight readiness? Real-time flight readiness is needed to properly control taxi queue lengths for departing flights. If various flight operators calculate flight readiness in a different manner, then that variable will impact proper queue of taxiing aircraft. Generally every departure notification of readiness to taxi to ATC (or some local control entity) is only known real-time. If an airport is going to control and allocate taxi queues, then flight readiness must be predicted, so the operator is required to indicate this readiness prediction. For each operator, this readiness indicator might be different. To simplify this readiness state, ACDM efforts plan to utilize a readiness time, the predicted EOBT, and not a readiness indicator.
- How should arrival and departure runway configurations be utilized by ATC? ATC can apply a preference based on demand. For example, for dual-use runways—those utilized for both arrivals and departures—increased spacing between successive arrivals provides more capability for departures to utilize the same runway. In European ACDM efforts, this utilization is left to ATC with the understanding that the utilization will capture the maximum amount of capacity instead of favoring one operator. NASA is conducting considerable work in this area of airport configuration management and the idea that configuration could be predicated

Table 7. Other barriers to ACDM implementation.

Airport Relevant Barriers	Possible Mitigation
ACDM Implementation Cost: Includes equipment, software, additional staff costs, and training	Even though not required, this is the advantage of performing Benefit-Cost Analysis (BCA) detailed in Chapter 6. These include reduction in emissions. airport brand enhancement, improved customer experience, reduced taxi-out delays, handling of flight diversions, etc.
Introduction of the ACDM Philosophy to Airport Staff: Includes new procedures and tasks, and acceptance of new working relationships by airport staff	CDM history has shown that these barriers will arise. Public commitments by airport senior staff, collaborative development of program goals including means to measure success, and an active feedback loop to address concerns are all extremely important in mitigating these type barriers and should receive robust attention.
Modification of Contractual Agreements: Includes those with vendors/contractors performing ramp control functions	Past experiences in times of airport construction that required process changes to implement mitigation procedures, these type barriers usually did not exist if they were part of the ACDM process that developed the changes. This reinforces the need for all stakeholder inclusion in the process.

and prepared for by a real-time prediction of all actual demand, including adjustments for the impact of ATC metering and other FAA traffic management initiatives.

Examples of some barriers that are particularly relevant to airports are included in Table 7.

Metrics Usage

In previous sections, we have discussed the value of metrics and the accountability and increased collaboration that occurs from their proper use. It must be stressed that metrics are not to be used to judge others. As previously illustrated, the ACDM projects or tests in the U.S. have shown that metrics of a particular project, determined by the ACDM effort, are a most valuable asset to support and improve collaboration. These same projects or tests have shown that metrics are not used to "grade" an operation, but to support and recognize the aim of future collaboration. As one ACDM participant is quoted, "We don't keep score." If this aspect is not continually stressed, especially in the early stages of ACDM, metrics will be used improperly and become a barrier (e.g., comparing one operator's on-time percentage to another's, rather than the on-time percentage for the entire airport operation).

Appropriate metrics will vary widely, depending on the nature of the ACDM project being undertaken. For example, a departure metering effort will likely focus on departure queue lengths, gate hold times, and information quality. In contrast, a de-icing program may focus on different metrics like time spent waiting for service, time spent on the de-ice pad, and a count of flights experiencing cascading delays.

The following depicts a list of possible metrics. The list is not intended to be complete, but to stimulate ideas for measuring the benefits of ACDM projects.

- Taxi-out time—length of time from ready for gate departure to actual runway off time. This metric could be subdivided into ramp delays and airport movement delays to source the root cause.
- Number of departure flights queued (waiting) at departure runway and time in queue—this could measure the fuel burn and associated environmental impact of departure queues.
- Actual number of flights departed during a certain period—measures departure efficiency.
- Length of gate hold for departure queuing—if departure efficiency is at a high level, length of gate hold with engines off measures associated fuel savings and reduced environmental impact.

- De-ice wait times, number of flights de-iced multiple times, times to actually de-ice, and actual number of flights de-iced—measures de-ice efficiency, queuing efficiency for de-ice, and proper demand for de-ice resources present.
- Time arrival flights waiting for a gate—measures gate usage efficiency.
- Length and wait times for CBP and TSA functions.
- Aircraft in time at the gate to baggage off load completed.
- Flight arrival and departure times during period where passenger comfort services are not available.
- Number of missed flight connections.
- Number of missed baggage connections.
- Metrics derived from the above:
  - Aircraft operating costs
  - Fuel consumption
  - Passenger travel time
  - Greenhouse gas (GHG) and noise emissions.

Proprietary Information

The proprietary barriers fall into two categories: security and economic. For example, in the security arena, if a display of highly accurate prediction of aircraft position were available, it could be utilized for targeting of a specific flight by terrorists. In the economic area, could it be utilized to gain a competitive edge or illustrate a competitor's weaknesses? These concerns are not new, but in any CDM effort, including ACDM efforts, all concerned must understand these barriers so that they do not destroy collaboration. ACDM participants must be aware that non-participants within their own company might want to use ACDM data for non-ACDM purposes.

Regulatory Issues

Concern for compliance with federal regulations (e.g., FAR Part 117, FAR Part 139, TSR 1542) is always very important to flight operators. For example, FAR Part 117 is the regulation that governs pilot duty time. Since one ACDM concept is holding aircraft at the parking gate to conform to a scheduled taxi time to control runway queue length, concerns might be expressed that this departure metering from the gate might influence pilot duty time issues. However, initial implementations have suggested that ACDM can actually help ensure compliance, as ACDM efforts and metrics make these predictions and conformance much more manageable to operators, especially at a location where departure readiness is forecast. This allows better management of the need to augment or change crews. The ability to forecast and act on these issues, rather than becoming subjected to them without foreknowledge, could be very valuable to flight operators. Similarly, other relevant regulations may actually become easier to approach in the presence of a developed ACDM program (e.g., impact of the three-hour tarmac rule).

Scalability and Applicability of CDM

As discussed, ACDM efforts will be different at different airports. The local ACDM community will address the issues that are present at that airport, so applicability is automatic. European ACDM efforts have proven ACDM scalability from applications at major hubs (Paris and Frankfurt Airports) to application at mid-sized airports (Brussels and Dusseldorf).

Can ACDM efforts be scaled to large hubs, medium or small hubs, or military/general aviation airports in the United States? The answer is not only yes, but also in certain locales it is going to

Table 8. ACDM applications without IT tools.

Problem Analysis	Data Attribute	Possible Source
Taxi-out times	Time elapsed from gate departure (OUT) to actual departure (OFF). FAA ATCT data often only includes Movement Area taxi time.	1. Flight operators 2. FAA ASPM data
Taxi-out times for a certain subset of flights, e.g., International or Inbound to a major hub. This to identify issues for a specific set of flights so that actionable times will not be lost in the larger average.	Time elapsed from gate departure (OUT) to actual departure (OFF). FAA ATCT data often only includes Movement Area taxi time.	1. Flight operators 2. FAA ASPM data
Gate availability issues	Do arrival flights have to hold in either the Movement Area or ramp area waiting for an available gate?	1. Flight operators 2. Airport operations
TSA wait times	Time entering TSA queue to clearing from it	1. TSA 2. Airport operations
Passenger services	Number of departure flights and passengers after service/vendor hours	1. Flight operators 2. Airport operations

be needed at smaller airports to allow ACDM efforts to operate at the large or main airport. For example, in the New York area, all departures from all the airports (Newark Liberty International, LaGuardia, John F. Kennedy International, Teterboro, Westchester County, etc.) utilize the same departure fixes. To properly allocate the departure resource, departure demand at all of these airports is needed by ATC, not just the major airline passenger airports. The further in advance this demand is known, the better the allocations can be distributed.

Another question often asked is whether smaller airports with limited resources can implement ACDM without sophisticated automation or decision support tools. In other words, is data alone sufficient? The answer to the question is a theoretical "yes." Theoretical in that implementation of ACDM concepts on this scale has never been attempted and actionable data probably will not be available real-time, but action on analysis data could be useful. Table 8 depicts some possible examples of "data" applications and the attributes of that data. Please note that none of the FAA/Industry CDM data products are utilized, as that requires some type of IT attribute to obtain this data. A prime source for such aircraft movement data might be the Aviation System Performance Metrics (ASPM) database. ASPM is an FAA database of the National Airspace System, a part of FAA Operations & Performance Data and although password protected would generally be available to airports via web access after coordination with the FAA facility.

Departure Reservoir Coordinator

The CDM Surface Concepts Team concept of an airport Departure Reservoir Coordinator (DRC) has only been put into practice at JFK International Airport. The full ACDM application of this DRC concept will generate issues that will need to be addressed due to differences in airport attributes. One issue that has not been addressed in the New York area is that departures from all New York airports utilize the same departure "gates" for transitioning to the en route portion of flight. Since the same departure "gates" are utilized, how will the DRCs at JFK, EWR, and LGA coordinate with each other when staging departure flights to the same departure "gate"? The question has been discussed and is expected to be addressed in the future as the FAA TFDM program matures.

CHAPTER 6

The Case for Quantifying ACDM Benefits

Airports routinely make investment decisions based on their operational, strategic, safety, financial, and environmental objectives. The goal of these decisions is to identify the most prudent investment of public funds—the alternative that generates the most value per dollar invested over the lifecycle of the project. While airports always quantify the cost of a project, the benefits are usually treated in a qualitative matter. For some projects, alternatives may be treated quantitatively—the reduction in noise or increase in capacity may be measured. However, unless these quantities are converted into monetary terms by assessing the economic value of the benefits, which is often a challenging task, they cannot be directly compared to the costs of each alternative.

Role of Benefit-Cost Analysis

This Guidebook includes a primer on the development of a benefit-cost analysis (BCA)—a formal comparison of the monetized value of the project's benefits against its costs. However, with few exceptions, BCAs are not required to be conducted for airport-funded projects. Since developing the BCA represents a cost in and of itself (either by hiring a consultant or assigning airport staff labor resources), airports must consider on a case-by-case basis whether the project warrants an analysis of monetized benefits. In making these decisions, the airport should consider the following questions:

- ***What is the approximate lifecycle cost of the system?*** Establishing a rough order-of-magnitude (ROM) cost estimate can help to determine the merit of a BCA. If the ROM cost suggests that acquiring and maintaining the system represents a major expense, the value of the BCA increases. A major benefit of the BCA is ensuring that the airport receives maximum value for its limited capital funds. This is of particular importance in the case of larger investments that compete with other potential acquisitions and construction.
- ***What other projects are competing for the same source of funds?*** In cases where there are dissimilar projects whose benefits may be difficult to compare, the BCA helps to clarify the value of each alternative in a succinct way. In cases where there are similar projects competing for funding, or different alternatives within one project, the BCA provides rationale for selecting the best option. For acquisition of commercial-off-the-shelf (COTS) systems, the BCA can provide more objective metrics than manufacturers' claims.
- ***What review and administrative processes are required for the investment decision?*** If the processes for arriving at an investment decision are complex, the value of the BCA increases. For example, if the investment decision requires environmental reviews, public participation, stakeholder coordination, and/or formal approval by a board or authority, the ability to present a structured analysis with quantified benefit metrics can help to strengthen the case

for the investment. The BCA provides decision-makers with comprehensive data on the net economic value of each alternative under consideration.

- ***What risks and uncertainties exist that may affect successful implementation of the project?*** The risk management step of the BCA provides an opportunity to identify uncertainties that may jeopardize both the investment decision itself and the outcomes of the project. This helps to ensure a comprehensive treatment of risk factors. Moreover, if a quantified risk analysis is performed as part of the BCA, the lifecycle benefits and cost estimates derived in a BCA analysis can be associated with specific probabilities of success. This allows the decision-makers to dial in a specific willingness to assume risk. For example, in its own investment decisions, the FAA adopts a conservative approach by comparing the 80th percentile of the cost estimate against the 20th percentile of the benefit estimate.

The BCA is not normally used to draft the specifications for the desired ACDM system. However, the BCA methodology can be used to rate several design alternatives derived from the airport's operational needs. The BCA can then be used to compare and rank the alternatives or individual options in a portfolio of candidate enhancements. Using an iterative process, the BCA methodology can help to fine-tune the design of the specifications by eliminating or revising elements that are not cost-effective.

Even if the airport determines that a BCA is not warranted, the BCA principles presented here can add considerable value in supporting the investment decisions. Examples include the following:

- Identifying specific benefit mechanisms helps to structure the discussion of the investment decision.
- Benefits that are quantified, but which are not monetized, can be used to evaluate the relative benefit of alternatives. Possible examples include reduced risk of controller errors or reductions in GHG emissions.
- BCA principles encourage planning around lifecycle benefits and costs instead of focusing on the initial acquisition costs or benefits in a specific year. This is significant since the majority of costs often occur at the beginning of the lifecycle, whereas benefits often grow during the course of a lifecycle as traffic increases and the system matures.
- BCA principles consider opportunity cost. This represents the economic value of alternative uses of the airport's capital funds, including the value of no-build or no-buy alternatives. The BCA takes into account the change of the value of money over the course of the lifecycle, which can be significant for capital projects.
- BCA principles encourage the airport management and planning staff to consider risks and uncertainties. Examples include uncertainties in activity forecasting, the risk of cost escalation, unpredictable fuel prices, etc.

Note that when public entities are involved, such as airports or air navigation service providers, the BCA approach considers the total benefits and costs to society as a whole. The benefits analysis can be structured to identify how benefits accrue across individual stakeholders (i.e., airports, carriers, the traveling public, and neighboring communities), but the investment decision should be based on the combined benefits across all stakeholders:

> The first critical point is that BCA focuses on the "net social benefit" or "social return on investment." In this context, the word social refers to societal benefits and costs, which include public, private, and government benefits and costs. Ideally, it is used to identify all impacts to society associated with taking an action, regardless of whether the impacts come as a cost or benefit or whether they are borne by the government or a direct beneficiary or a third party. In economic terms, BCA can identify which project maximizes net social benefit (Landau and Weisbrod 2009, p. 9).

Even if an airport is considering an investment where it carries all the cost and the airlines accrue all the benefits, it would potentially have a positive BCA determination if the benefit-cost ratio is greater than one. Subsequent to the investment, the airport can seek cost recovery through its regular rate-setting mechanisms and tenant negotiations so that the costs associated with achieving the benefits are equitably shared.

Potential ACDM Benefits

In the case of ACDM, the specific benefits will vary depending on the application. Based on previous research and studies of existing CDM implementations, some of the key sources of benefits likely include the following. Note that several of the benefits identified would require participation by the ATC facility at the airport. This may preclude some of the benefits from being realized, or at least fully realized, through commercial ACDM applications intended primarily for use by the airport staff. In general, the greater and ardent the formal participation of the airports' stakeholders, including ATC, the broader the range of potential benefits.

Better Management of Airport Resources

Coordination and data exchange can provide airports with more accurate information on resource use. Better information on short-term gate needs can help with tactically allocating gates to meet demand, while historical data on gate and taxiway usage can help both for long-term planning purposes and to monitor conformance with airport use agreements. In adverse conditions, data sharing may alert airport operators to events that will put a strain on their resources, such as multiple diversions heading to the airport in a short period of time. With more advanced awareness of the situation, airport operators can more effectively plan their response and utilize their resources in a way that minimizes the disruption to regular operations and to the passengers. With greater coordination among stakeholders, airports can recover more quickly from events that disrupt normal operations (such as snow or fog). This reduces the delays experienced by passengers and increases the throughput of the airport.

Reduced Congestion

Sharing information such as traffic demand, predicted delays, and impacts from traffic management initiatives will give operators more insight into issues affecting a flight before it leaves the gate. Additional coordination based on this insight can result in a better balance between time spent at the gate versus time spent taxiing. Airports can achieve reductions in queue lengths and taxi-out times by holding aircraft at the gate in a virtual queue when departure demand is high rather than having all aircraft competing for runway access. Flights with specified departure times assigned by the FAA's various automation initiatives can receive that information prior to leaving the gate. Delay can be absorbed in the Non-Movement Area with engines off instead of learning of delays after an aircraft has already begun taxiing. Shifting delay from the taxi phase to the gate or Non-Movement Area will reduce airline operating costs and fuel consumption, resulting in improved air quality, a reduction in GHG emissions, and reduced noise impacts.

Figure 7 graphically represents the pool of benefits that can be targeted by a CDM system to reduce taxi delay. The benefit begins with the concept of unimpeded taxi time—the theoretical minimum or ideal time required to taxi from the gate to the runway in the absence of any inefficiencies or delays. The difference between the unimpeded taxi time and the actual taxi time represents a pool of delay that is the target of potential improvements. This pool is the combination of all sources of delays and inefficiencies, such as gate delays, taxiway inefficiency due to suboptimal sequencing, and runway queuing delay. The economic value of the pool, expressed in excessive fuel consumption, operating costs, etc., represents the so-called shortfall—the gap

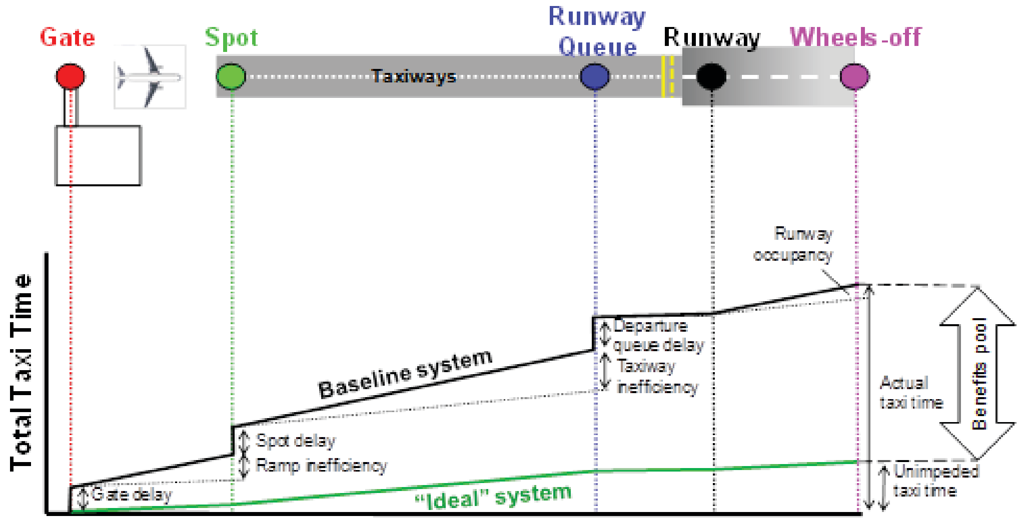


Figure 7. Potential benefits pool for reduced taxi delay (FAA 2010, pg. 35).

between the actual system in place at the airport and the ideal, unimpeded one. The portion of this pool that can be reduced as a result of improvements attributable to CDM represents the economic value of the taxi delay reduction benefit.

Data can be collected to assess the size and nature of the taxi delay shortfall. As an illustration of such an analysis, Figure 8 displays average taxi delay times for a sample of airports. The sample consists primarily of larger commercial airports where taxi delays are more prevalent. The

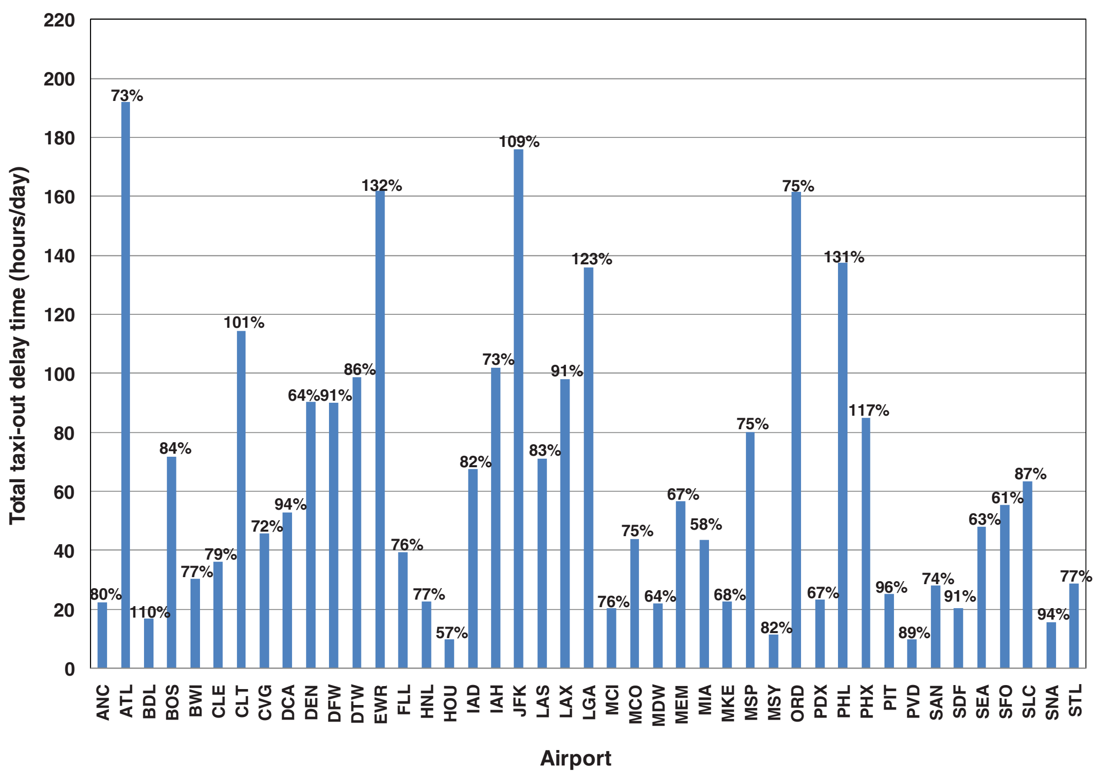


Figure 8. Average taxi-out delay (FAA 2010, pg. 35).

percentage value above each bar is the ratio between average actual taxi times and unimpeded taxi times and is an approximate measure of the relative size of the potential benefit pool.

Increased Flexibility and Predictability

Data exchange and improved coordination can give airlines, ATC services, and airport operators more flexibility to prioritize and re-sequence flights based on business needs or other concerns. For example, flight A that has already experienced a significant delay may be able to swap its departure time with flight B that is on-time or early in order to minimize the impact of the delay. Figure 9 shows a notional swapping algorithm similar to what might be implemented in CDM systems to improve the distribution of delays incurred by aircraft, and Figure 10 illustrates a sample swap. As shown in the example, even when there is no net reduction in delay, spreading the distribution of the delay across multiple flights can benefit operators and passengers. This is because when a flight incurs large delays, the risk increases for missed passenger connections, missed baggage transfers, and for the crew to reach its flight duty and flight time limits. The information on which such a decision would be based is typically known to the flight operator, while execution of the decision may fall within ATC's jurisdiction. Collaboration is the key to recognizing and acting on such opportunities involving multiple parties.

In addition to optimizing the sequencing of flights, ACDM can potentially increase predictability, for example by increasing the precision and accuracy of departure times. The runway departure process can be modeled as a queue with a probability distribution of service times (i.e., time intervals between successive departures). In an airport operation with low levels of predictability, the service time has a relatively high variance. A fundamental result of queuing theory is that the greater the variance in service times, the greater the resulting delays. Increasing predictability lowers the variance and should result in less delay. This is illustrated in Figure 11, which demonstrates how reducing the uncertainty in the service time results in a reduction of runway delay estimates generated using a queuing model applied to a small sample of airports.

Improved Safety

ACDM can potentially provide several opportunities for improving the safety of airport operations. At its most basic, data sharing improves situational awareness among the stakeholders so that decisions can be made with more complete information on safety considerations. An overall reduction in surface congestion reduces potential conflicts and can lead to fewer accidents and incidents. More advanced applications of CDM could include methods of monitoring conformance to taxi paths, further reducing the risk of accidents from surface operational errors, aircraft tugging operations by non-pilots, or taxi route deviations.

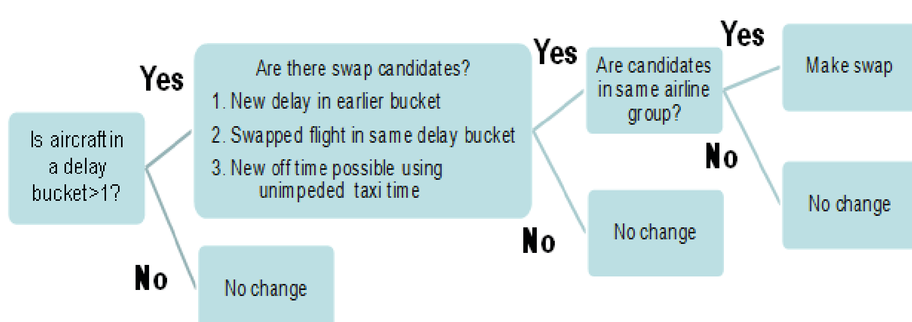


Figure 9. Sample decision process for flight-swapping algorithm (McInerney and Howell 2011, pg. 4).

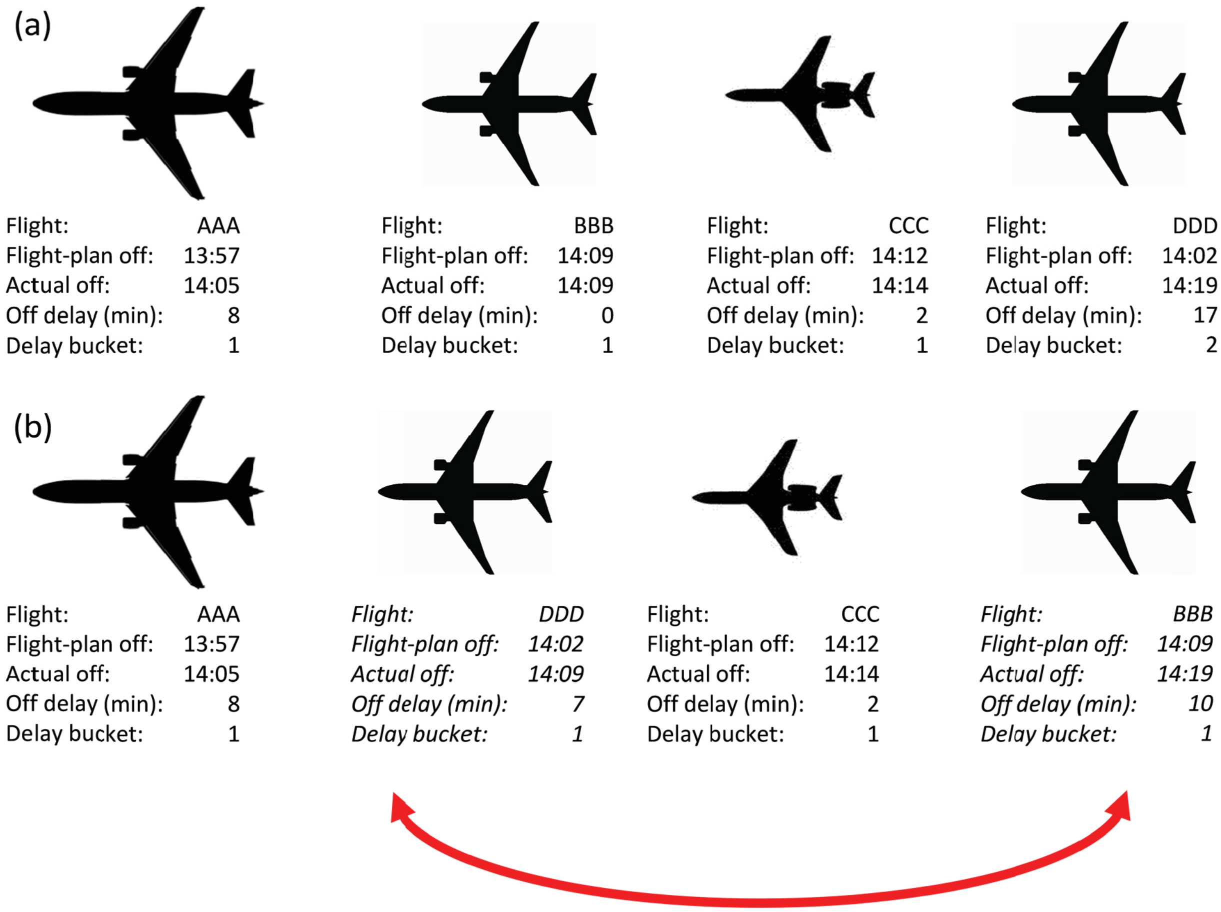


Figure 10. Flight-swapping example for improved delay distribution (McInerney and Howell 2011, pg. 5).

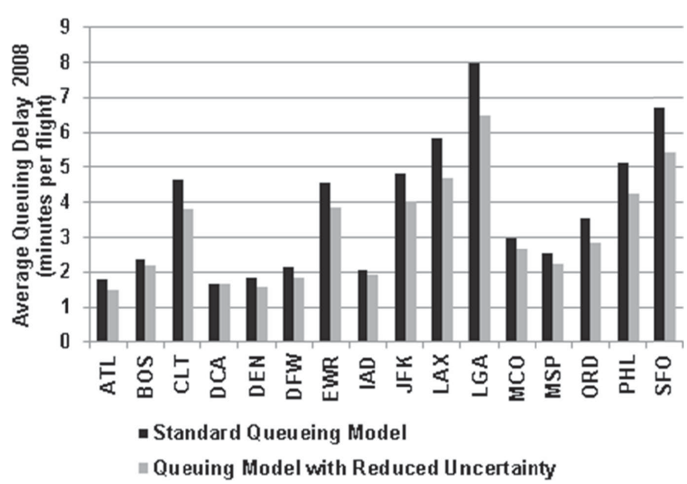


Figure 11. Impact of improved predictability on delay (FAA 2010, pg. 42).

Increased Opportunities for Data Collection and Assessment

ACDM data exchange capabilities could provide an opportunity to collect and record operational data that are important for airport planning purposes. New data archives may allow certain data processing actions to be automated and increase time available for other tasks. Further, additional tracking and record keeping may allow for real-time review of events or a centralized, post-event review of actions to identify areas where performance and practices can be improved. The timely sharing of operational data among stakeholders assists in the evaluation and improvement of the airport's and stakeholders' performance. For example, mowing and taxiway light maintenance can be planned around real-time lulls in operations rather than less accurate scheduled ones.

System Consolidation

Data exchange and improved situational awareness under ACDM can identify inefficient processes and consolidate tasks, resulting in a more streamlined operation. In certain configurations, modern ACDM systems may be able to replace a conglomerate of existing, standalone systems, each with their own hardware, display, and maintenance costs. In addition to streamlining airport operations and planning functions and improving situational awareness, this may potentially result in a net cost savings.

Other Benefits

During the stakeholder outreach effort conducted as part of this project, the Research Team interviewed several airport operators and aircraft operators to document existing challenges and benefits. One airport operator reported that it had collected testimony from its stakeholders in order to document perceived benefits. Examples of the benefits described by the airport's stakeholders include the following:

- Sharing of information, improved situational awareness, and more efficient decisions during IROPS and winter operations;
- Increased throughput during winter weather events;
- Improved schedule compliance;
- Reduced fuel consumption and GHG emissions (210,000 gallons of fuel and 1,700 tons of CO_2 emissions for the carrier in question);
- Optimized scheduling of flight dispatchers, improving time-on-duty; and
- Improved communications within meteorological technical group attributed to web-based technologies.

As described in Chapter 3, certain airports frequently receive diversions from nearby airports. The airports that generate the diversions are often larger metropolitan airports, such as hub airports, whereas the receiving airports are often smaller, regional airports. A solitary aircraft diversion, for example due to a medical emergency, is not likely to substantially disrupt operations at the receiving airport. Conversely, serial diversions of multiple aircraft, for example due to a winter weather event, can severely disrupt operations for an extended period of time. Such diversions have the potential to create large and unexpected peaks of demand that exceed existing airport capacity, particularly at the terminal and in the taxiway-apron system.

The Guidebook validation exercise conducted as part of this project identified several specific challenges associated with the handling of diversions:

- Delays due to surface congestion;
- Delays due to limited gate availability;

- Delays due to limited refueling and/or de-icing capacity;
- Delays due to limited availability of federal security and inspection services; and
- Financial penalties associated with extended tarmac delays.

These problems are compounded by the inability to plan for the best use of the airport's limited resources due to high levels of uncertainty regarding the number and timing of inbound diversions.

The presence of ACDM capabilities may not be sufficient to eliminate these challenges, but has the potential to reduce the negative impacts by providing an estimated arrival time for each diversion. Consequently, in the case of diversions, a major benefit of ACDM is the ability to reduce uncertainty. The impact, quantitatively, would be a reduction in the operating and fuel costs associated with delays, an accompanying savings in passenger travel time, and a potential reduction or elimination of DOT fines for extended tarmac delays. These benefits may be quantifiable and could then be included in a benefits analysis as described herein. Alternatively, they could be described qualitatively in support of the business case for the ACDM investment.

Sample ACDM Benefits Analysis

In order to illustrate the concepts described in this chapter, this section provides a step-by-step example of quantifying the value of a specific ACDM benefit. The example does not assume a specific ACDM platform or implementation, however. This example uses Richmond International Airport, a regional airport with approximately 100,000 annual operations and 1.6 million annual enplanements. The focus is on a regional airport to demonstrate that even small airports (relative to hubs) can accrue substantial economic benefits over the lifecycle of an ACDM solution.

Note that in a full BCA, several preliminary steps are usually included which are skipped here. Figure 12 is a notional diagram that illustrates the steps normally required to conduct a BCA.

This example assumes that several of these steps have already been completed, including establishing the overarching objectives, identifying alternative solutions, and researching and determining the appropriate methodology for evaluating the benefits. Also, this example only covers the calculation of benefits, so the steps that refer to analyzing costs and comparing benefits against those costs are not included.

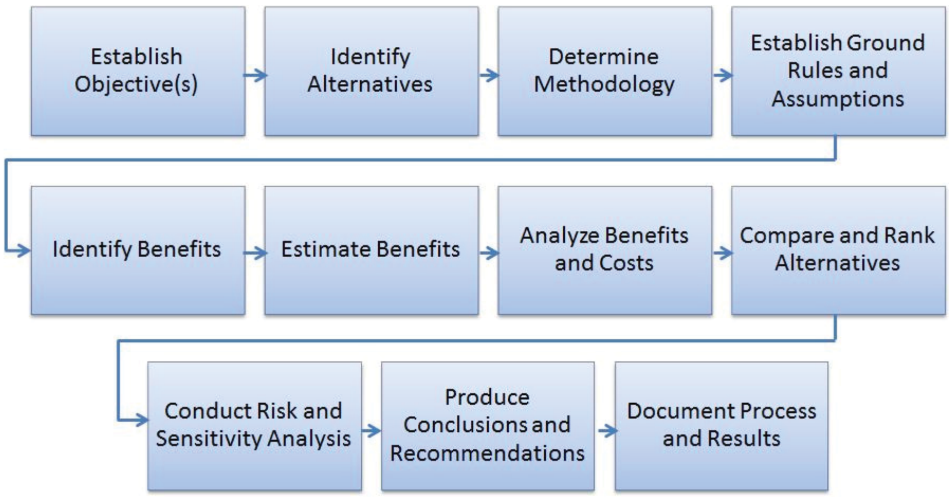


Figure 12. The BCA process.

Step 1: Establish Ground Rules and Assumptions

This sample benefits analysis incorporates the following assumptions:

- The project lifecycle is 20 years, beginning in 2017 and ending in 2036.
- Future demand is given by the FAA's Terminal Area Forecast. To account for uncertainty in the forecast and to ensure the benefits estimate is conservative, activity levels are assumed to be flat beyond 2025.
- Economic values (including aircraft operating costs) are based on the guidance provided in the FAA's *Economic Information for Investment Analysis.*

Note that this example considers a relatively large investment in a NAS-wide system with periodic technology upgrades, warranting the use of a 20-year lifecycle. Smaller investments in COTS ACDM systems and decision support tools will most likely have shorter lifecycles—5 to 10 years, depending on whether upgrades are included in the business case.

Step 2: Identify Benefits

In the absence of ACDM, aircraft are assigned departure release times after push-back from the gate when certain types of demand management procedures are in effect, such as en route spacing programs. This is because air traffic controllers lack accurate push-back time estimates. This means that any Call for Release (CFR) delay must be taken during the taxi phase instead of at the gate. With ACDM and the associated data exchange capabilities, the departure release time can be predicted accurately prior to push-back. This allows for the CFR delay to be absorbed at the gate prior to engine start, creating fuel savings that translate into a cost savings for the aircraft operators.

Benefit: Reduced fuel consumption due to absorbing CFR delay at gate instead of during taxi

While this example only considers the monetary value of the fuel savings, there are several environmental benefits associated with reduced fuel consumption. These include reductions in noise and emissions. Environmental impacts can also be quantified in terms of their economic value to society, and should be considered in a complete BCA.

Step 3: Estimate Benefits

The following methodology was used to compute the CFR benefit:

- Use 2012 data from the joint NASA/FAA Operational TMA/TBFM Repository (OTTR) system and the FAA's ASPM database to measure the total taxi-out delay for each CFR flight.
- Since non-CFR flights also have taxi-out delay, the average taxi-out delay for non-CFR flights was calculated using 2012 data from ASPM (3.34 min).
- The net CFR delay savings was calculated as the total taxi-out delay for each flight, less the sum of a 10-minute buffer to account for uncertainty in surface modeling and the 3.34-minute buffer representing the average taxi-out delay for non-CFR flights. Flights with a total taxi-out delay less than the total buffer of 13.34 minutes were assigned a zero benefit.
- The CFR delay benefit represents a shifting of delay from the taxi phase to the gate phase. To monetize the benefit, the difference between the Aircraft Direct Operating Cost (ADOC) during the taxi phase and the gate ADOC was used. This difference represents the portion of ADOC that can be attributed to the additional fuel consumption incurred during taxi. Average gate and taxi ADOC values were obtained from the FAA's *Economic Information for Investment Analysis* by TAF aircraft category (i.e., air carrier, commuter and air taxi, general aviation, and military). To calculate specific ADOC values for Richmond International Airport, a weighted average was computed for each year in the lifecycle using the predicted share of operations in each category according to the aircraft operations forecast of the TAF.

Table 9. Sample benefits case—net CFR delay, Richmond International Airport, 2012.

Flights in Sample	With Net CFR Delay > 0 min	Avg Net CFR Delay (min)	Total CFR Delay (hrs)
42,272	717	10.4	125

Table 9 summarizes the analysis of the OTTR and ASPM data sample used to assess the net potential CFR delay savings.

For CFR flights, the net delay in excess of the buffer was 10.4 minutes, resulting in a total CFR delay of 125 hours per year. In order to estimate the monetary value of this potential delay savings, the CFR delay was grown using the TAF, with growth capped beyond 2025, and monetized using the portion of the ADOC attributable to fuel consumption. The resulting benefit, expressed in 2014 dollars, is shown in Table 10.

Note that when monetizing the benefits it is important to use real dollars throughout the lifecycle. Real dollars (or constant dollars) have been adjusted so as to exclude the effect of inflation. This allows for the benefits to be compared from year to year across the lifecycle. It also prepares the analysis for the final step, discounting the benefits to take into account the future value of money. In this step, the benefits are converted to their present value (PV) using a specified rate used to discount future dollars. In this example, a real discount rate of 7% was used. This is the recommended value for the FAA's own investment analyses, per the FAA's *Economic Information for Investment Analysis.* Airports should consult with its planning and finance staff to determine the appropriate discount rate for its BCA studies.

Table 10. Sample benefits case—lifecycle benefits of CFR delay savings, Richmond International Airport.

Year	Operations Forecast	CFR Delay Savings (hrs)	Fuel Portion of ADOC (2014 $/hr)	Benefit (2014 $)
2017	105,144	132	$404	$53,208
2018	107,938	135	$411	$55,648
2019	110,836	139	$419	$58,233
2020	113,842	143	$427	$60,970
2021	116,959	147	$436	$63,864
2022	120,191	151	$444	$66,925
2023	123,542	155	$453	$70,159
2024	127,016	159	$462	$73,575
2025	130,617	164	$472	$77,180
2026	130,617	164	$472	$77,180
2027	130,617	164	$472	$77,180
2028	130,617	164	$472	$77,180
2029	130,617	164	$472	$77,180
2030	130,617	164	$472	$77,180
2031	130,617	164	$472	$77,180
2032	130,617	164	$472	$77,180
2033	130,617	164	$472	$77,180
2034	130,617	164	$472	$77,180
2035	130,617	164	$472	$77,180
2036	130,617	164	$472	$77,180

Converting benefits into PV dollars takes into account the notion that benefits accrued today are more valuable than those earned in the future. This is because the savings generated by the benefit can be invested and generate a return during the interim years. The rationale for expressing benefits in PV dollars is explained further in *ACRP Synthesis 13: Effective Practices for Preparing Airport Improvement Program Benefit-Cost Analysis* (Landau and Weisbrod 2009, p. 10):

> PV measures the current worth of a stream of future costs and a stream of future benefits (expressed in money terms), based on the concept of the "time value of money." An annualized "discount rate" is applied to represent all future year benefits and costs in terms of their "present value." This is done because, after adjusting for inflation, people would rather receive a dollar now than receive a dollar several years from now (since a dollar received now can be put to productive use that is foregone if the dollar is received later).

The PV of a benefit value for a single year in the future is given by:

$$PV_t = \frac{B_t}{(1+r)^{\Delta t}} \qquad \text{(Eq.1)}$$

where B_t is the annual benefit in year t, expressed in real dollars, r is the real discount rate, and Δt is the number of years into the future that the benefit is accrued. The PV of the entire lifecycle stream of benefits is then simply the sum of the PV of the benefit accrued each year in the lifecycle. In this sample benefit analysis, the lifecycle benefit of taking CFR delay at the gate instead of during taxi is approximately PV $634,000 (see Table 11). Figure 13 uses this sample benefits case to compare and contrast the economic value of the associated benefits expressed in real dollars to their economic value expressed in PV dollars.

Table 11. Sample benefits case—present value of benefits of CFR delay savings, Richmond International Airport.

Year	Δt	Benefit (2014 $)	PV Discount Factor	Benefit (PV $)
2017	3	$53,208	0.816	$43,434
2018	4	$55,648	0.763	$42,454
2019	5	$58,233	0.713	$41,520
2020	6	$60,970	0.666	$40,627
2021	7	$63,864	0.623	$39,772
2022	8	$66,925	0.582	$38,951
2023	9	$70,159	0.544	$38,162
2024	10	$73,575	0.508	$37,402
2025	11	$77,180	0.475	$36,668
2026	12	$77,180	0.444	$34,269
2027	13	$77,180	0.415	$32,027
2028	14	$77,180	0.388	$29,932
2029	15	$77,180	0.362	$27,974
2030	16	$77,180	0.339	$26,143
2031	17	$77,180	0.317	$24,433
2032	18	$77,180	0.296	$22,835
2033	19	$77,180	0.277	$21,341
2034	20	$77,180	0.258	$19,945
2035	21	$77,180	0.242	$18,640
2036	22	$77,180	0.226	$17,421
			Total:	**$633,946**

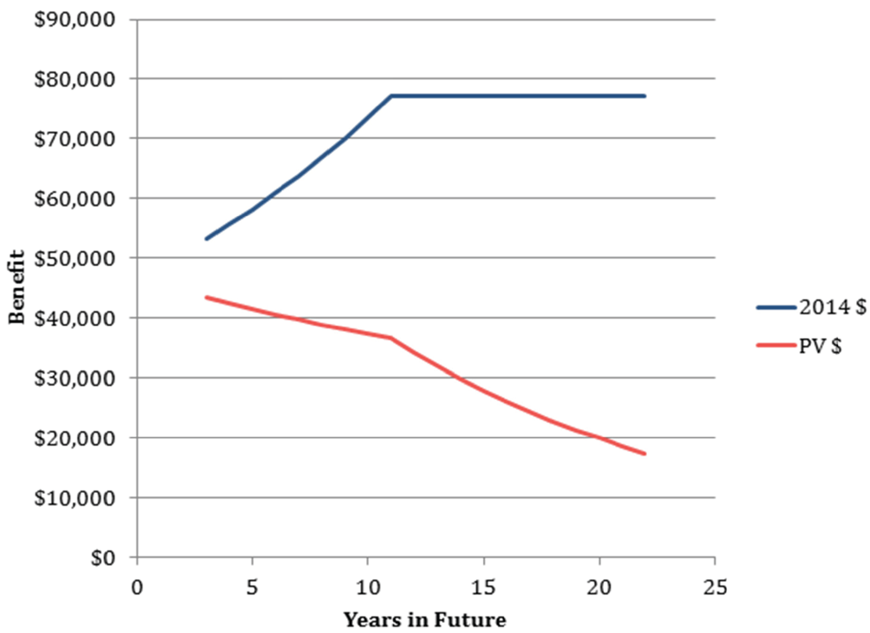


Figure 13. Benefits example—comparison between real dollars and present value.

The comparison between real and PV dollars highlights the notion that the further in the future benefits are accrued, the less they contribute toward the business case for the ACDM investment under consideration. This is significant, for two reasons:

- The cost side of a benefit-cost comparison involving an ACDM investment is often dominated by hardware and software acquisition costs. These occur early in the lifecycle and are therefore discounted much less than the benefits, which tend to be spread throughout the lifecycle. In other words, ACDM acquisition costs are likely to carry more weight, on a relative basis, than benefits.
- ACDM benefits attributable to operational efficiencies, such as fuel savings, often grow as traffic increases. However, this growth in benefits is offset by the discounted value of future dollars. Unless the benefits grow at a higher rate than the discount rate, they will decline in value through the lifecycle, as is the case in the example shown here.

As shown in Table 11, in this particular example, the PV of a benefit accrued in the first year in the lifecycle is discounted by a total of 18.4%. Conversely, the PV of a benefit accrued in the tenth year of the lifecycle, is discounted by 55.6% and the PV of a benefit in the final year is discounted by 77.4%.

Additional Steps

As shown in Figure 12, in a complete BCA the PV of the lifecycle benefits would then be compared against the lifecycle costs, also expressed in PV dollars. The cost estimate normally consists of a number of cost components, including:

- Acquisition costs
- Operations and maintenance costs
- Labor costs
- Training costs
- Tech refresh costs

An important step in the BCA process is the risk and sensitivity analysis. The purpose of this step is to identify uncertainties in the analysis and their impacts on the results. Examples include forecasting errors and inherent uncertainties that are present when simplifying assumptions are used. This step helps ensure that the investment decision is conservative and allows the risk for cost overruns to be quantified and managed. Several statistical techniques are available to conduct the risk and sensitivity analysis, including Monte Carlo simulation. A full description of these techniques is beyond the scope of this Guidebook. The example described in this chapter does include specific measures to ensure the benefits estimate is conservative, however. These include the assumption of flat growth beyond 2025 and incorporating a 10-minute buffer to account for the uncertainty in surface modeling.

CHAPTER 7

Conclusion

ACDM is a process, not a project. To recap, it requires the following elements:

- Everyone needs to realize that a better airport operation benefits everyone. Many issues should be addressed by the whole operation rather than individual entities.
- Success will require commitment of airports and participant resources, particularly staff time. ACDM is not a quick fix, and meetings must be frequent.
- All impacted entities need to be included, even those that have little technical knowledge of the issue being addressed.
- Team building and trust must be established. Data sharing and group goals are for the benefit of the entire airport, not one entity.
- Data availability must be guarded and protection provided from use for competitive reasons between participating entities. There is a great deal of data available, and transitioning data to useable information is a group effort.
- Sharing of knowledge and experience is critical. Airport and flight operations staff have valuable experience and knowledge, and different perspectives can ensure a valuable end product that benefits everyone. This includes sharing of ACDM experience between airports.
- Metrics should be utilized to measure success. Even though a formal BCA will not usually be required, success and benefits need to be measured to improve the next application.
- Lessons learned should be tabulated for future efforts. This includes sharing experiences at Airports Council International–North America (ACI–NA); American Association of Airport Executives (AAAE); and similar conferences so that other airports can understand the principles and practices.

As mentioned previously, a series of checklists are provided in Appendix B to guide the airport through an ACDM application. Please refer to those to begin the ACDM process.

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APPENDIX A

Acronym Glossary

Acronym	Definition
A4A	Airlines for America
AAAE	American Association of Airport Executives
ACDM	Airport Collaborative Decision Making
ACI–NA	Airports Council International–North America
ADL	Aggregate Demand List *This is a list of the most current active and proposed flight plans, including all amendments. This listing is available only through access to the FAA/Industry CDM AOCnet.*
ADOC	Aircraft Direct Operating Cost
ADS-B	Automatic Dependent Surveillance Broadcast
AFP	Airspace Flow Program
AIXM	Aeronautical Information Exchange Model *Standardized format for exchanging aeronautical information*
AOBT	Actual Off Block Time
AOC	Airline Operations Center
AOPA	Aircraft Owners and Pilots Association
ARFF	Airport Rescue and Fire Fighting
ARTCC	Air Route Traffic Control Center
ASDE-X	Airport Surface Detection Equipment Model X *Surveillance system involving triangulation of transponder signals, ADS-B Out broadcast, and primary skin paint radar*
ASDI	Aircraft Situation Display for Industry
ASPM	Aviation System Performance Metrics
ASSC	Airport Surface Surveillance Capability
ATC	Air Traffic Control
ATCSCC	Air Traffic Control System Command Center
ATCT	Air Traffic Control Tower
ATFM	Air Traffic Flow Management
ATM	Air Traffic Management
BCA	Benefit-Cost Analysis
CBP	Customs and Border Protection
CDM	Collaborative Decision Making *Usually refers to the official FAA/Industry CDM program*
CFR	Call for Release
CIWS	Corridor Integrated Weather System
COBT	Controlled Off Block Time
COTS	Commercial Off-the-Shelf

CSG	CDM Steering Group *The group that oversees all activities conducted under the FAA/Industry CDM Program*
CTOP	Collaborative Trajectory Options Set
DMP	Departure Metering Procedure
DOT	Department of Transportation
DRC	Departure Reservoir Coordinator *The departure metering function to optimize efficient taxi out queues*
EFB	Electronic Flight Bag
EOBT	Estimated Off Block Time
ESP	En route Spacing Program *Optimizes departures to fit in the overhead stream*
ETA	Estimated Time of Arrival
ETOT	Estimated Taxi-Off Time
EWR	Newark Liberty International Airport
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FBO	Fixed Based Operator *Generally the operation area from which business and general aviation flight operate*
FID	Flight Information Display
FIXM	Flight Information Exchange Model *Standardized format for exchanging flight information*
FSM	Flight Schedule Monitor *The FAA/Industry CDM Tool that displays demand and forecasts period of time that demand will exceed the desired level*
GDP	Ground Delay Program *FAA-instituted flight delay program to control volume of demand*
GHG	Greenhouse Gas
HITL	Human in the Loop Simulations
HPN	Westchester County Airport
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
IOBT	Initial Off Block Time *Long-range forecast of flight desired time from parking*
IROPS	Irregular Operations
IT	Information Technology
ITWS	Integrated Weather System
JFK	John F. Kennedy International Airport
LGA	LaGuardia Airport
LLWAS	Low Level Wind Shear Advisory System
MOA	Memorandum of Agreement
MOU	Memoranda of Understanding
Movement Area	The airport operational surface area (taxiways, runways, holding area, etc.) under positive ATC control; requires a clearance from ATC to enter
NAS	National Airspace System
NASA	National Aeronautics and Space Administration
NBAA	National Business Aviation Association
NEGS	National Enterprise Gateway System *The system that allows distribution of the FAA air traffic movement information to external sources*

NGIP	NextGen Implementation Plan
NOAA	National Oceanic and Atmospheric Administration
Non-Movement Area	The airport operational area not controlled by ATC, usually the ramps leading up to and including the aircraft parking area
NWS	National Weather Service
OAG	Official Airline Guide
OOOI	Out, Off, On, and In time message for a flight
OTTR	Operational TMA/TBFM Repository
PANYNJ	Port Authority of New York and New Jersey
PBN	Performance-Based Navigation
PDF	Portable Data Format
PDRC	Pre-Departure Release Control *The function to release departures from the parking area to realize optimum queues and to fit departures in the overhead stream to particular controlled airport*
POET	Post Operations Evaluation Tool
PV	Present Value
RAA	Regional Airline Association
RBS	Ration by Scheduling
RNAV	Area Navigation
ROM	Rough Order of Magnitude
RTCA	Radio Technical Commission for Aeronautics
RVR	Runway Visual Range
SCT	Surface Concepts Team *The team that is developing the CDM Surface Concept of Operations*
SEADOG	Southeast Airport Diversion Operations Group
SID	Standard Instrument Departure
SMS	Safety Management System
SOBT	Scheduled Off Block Time
SOC	Security Operations Center
SWIM	System Wide Information Management
TAF	Terminal Area Forecast
TBFM	Time-Based Flow Management *Scheduling flights by time to meet an optimum arrival rate*
TEB	Teterboro Airport
TFDM	Tower Flight Data Manager
TMA	Traffic Management Advisor
TMAT	Target Movement Area Entry Time *Where aircraft parking area is congested and that congestion might inhibit the capturing of a release time from a constrained area, the time to enter the ATCT Movement Area is used in lieu of a parking area release time*
TOBT	Target Off Block Time
TRACON	Terminal Radar Approach Control
TSA	Transportation Security Administration
TSR	Transportation Security Regulation
WESTDOG	Western Airports Disaster Operations Group

APPENDIX B

ACDM Implementation Checklists

This Guidebook includes several checklists to help airport operators in their efforts to implement ACDM programs. Development of these checklists was aided considerably by consulting *ACRP Report 65: Guidebook for Airport Irregular Operations (IROPS) Contingency Planning.*

In Appendix B, these checklists have been migrated to worksheets to facilitate establishment of the ACDM process. One attribute of the ACDM process is that it is applicable to a wide variety of applications. The attached worksheets are developed to be applicable to this variety, and thus some parts of each worksheet may not be applicable to a particular project. Each form may be used as-is, or it may be replicated and modified if the needs of a specific process are sufficiently unique as to warrant such.

To ensure that the ACDM effort begins successfully, these worksheets are designed to help initiate planning efforts and to gather feedback and, as such, are a supplement to maximize the value of stakeholder meetings.

Inclusion of the worksheets in this Guidebook does not necessarily indicate that airport staff leads the ACDM activity. As previously stated, airport staff participation is a key ingredient in a successful ACDM process, but the worksheets are not included to indicate required leadership by the airport staff.

Appendix B-1: Problem Definition Worksheet

The first stage in the ACDM planning process is identifying the problem to be solved (see Table 5 for examples). This will be an iterative process, but this worksheet is provided to begin collecting ideas and information to assist in developing an agenda for the first meeting.

It should be noted that the natural tendency in defining the issue at hand is to immediately jump to the solution stage. Awareness of this tendency is extremely important.

1. Describe in 1-2 sentences what issue/project is to be addressed with ACDM. Include the desired end state or goal of the project.

2. What is the impact or result of the above issue/project (air traffic delays, reduced capacity, passenger lines, environmental, etc.)?

3. Is there a timeline or deadline for this issue/project and if so, what is it?

4. Has the airport operator or other entity established a budget or cost ceiling and if so, what is it?

5. What are the risks/costs of maintaining the status quo (no action) on this issue?

6. Utilize Worksheet B-2 to determine the invitation list for the first meeting.

Appendix B-2: Impacted Stakeholder Identification Worksheet

Once the initial ACDM issue or project definition has been completed, the next need is to identify every stakeholder or entity that will be impacted by the issue or project. It is not necessary to establish the individual identity of the person representing each stakeholder. If it is unknown whether the project/issue will impact a specific stakeholder, then that stakeholder should be invited to the first meeting for self-determination of applicability.

Airport Personnel

☐ Administration (Finance, Contracts, Marketing, Business Development)
☐ Operations
☐ Planning
☐ Engineering
☐ Facilities Maintenance
☐ Airport Rescue and Fire Fighting (ARFF)

Flight Operators

☐ Passenger airlines with scheduled service, including both mainline and regional operators
☐ Other passenger carriers, if they have regional presence but no mainline operations
☐ Passenger airlines with regular charter service
☐ Cargo airlines with scheduled service
☐ Other cargo carriers, if they have regional but no mainline presence
☐ Cargo airlines with regular ad hoc service
☐ Military representatives from appropriate branches
☐ Recreational general aviation representatives
☐ Business jet operators with regular service
☐ Flight training providers
☐ Local/state government operators, including law enforcement and Medivac
☐ Unmanned aircraft systems operators

Airside/Ramp Service Providers

☐ Fixed base operators
☐ Fueling contractors
☐ De-ice contractors
☐ Catering providers
☐ Contract aircraft maintenance providers
☐ Aircraft manufacturers
☐ Snow removal providers

Official Services

☐ Local, state, and federal law enforcement agencies
☐ Private security contractors
☐ Transportation Security Administration (TSA)
☐ Customs & Border Protection (CBP)
☐ Environmental/wildlife agencies
☐ NOAA/NWS

Operational Control

☐ Ramp Control Tower
☐ Local ATCT, including military equivalent
☐ Local Terminal Radar Approach Control (TRACON) facility, including military equivalent
☐ Local Air Route Traffic Control Center
☐ Adjacent spaceport or range operators

Landside Service Providers

☐ Commercial ground transportation—taxi, shuttle, limousine, bus, etc.
☐ Public transit—rail, bus, etc.
☐ Food service
☐ Retail
☐ Airport hotel
☐ Janitorial
☐ Rental cars—on and off airport
☐ Parking lots—on and off airport, both airport- and privately operated

Community Stakeholders

☐ Local government authorities
☐ Local environmental organizations
☐ Community Part 150 regulations
☐ Information programs for surrounding communities

Appendix B-3: Participant Identification Worksheet

Using the same broadly identifying categories of related stakeholders, a roster and mailing list of the ACDM planning and implementation team is needed. A thorough list by stakeholder categories will foster communications and ensure inclusion in all discussions.

Airport Personnel

Organization	Name	Phone Number	Email Address

Commercial Flight Operators

Organization	Name	Phone Number	Email Address

Other Flight Operators

Organization	Name	Phone Number	Email Address

Airside/Ramp Service Providers

Organization	Name	Phone Number	Email Address

Official Services

Organization	Name	Phone Number	Email Address

Operational Control

Organization	Name	Phone Number	Email Address

Landside Service Providers

Organization	Name	Phone Number	Email Address

Community Interests

Organization	Name	Phone Number	Email Address

Appendix B-4: Guideline for First Meeting

Invitations to the first meeting should be sent to all entities determined from Worksheet B-2. The first meeting should include a brief discussion of the ACDM process, stressing the following attributes of ACDM:

1. Sharing of information, especially proprietary data, is meant to enhance the success of the project and is not for public distribution, scoring of performance, or competitive advantage.
2. Inclusion in the ACDM indicates willingness to be an active, engaged participant.
3. Successful completion of the project/issue is a win for all involved and requires trust and cooperation from all.

First Meeting Guidelines (meeting length should be no longer than 2–3 hours)

1. Welcome everyone and introduce all attendees; ensure that everyone has signed the Participant Identification Worksheet B-3.
2. Define responsibility of producing meeting notes.
3. Hold ACDM collaborative attributes discussion.
    a. Share information to solve the issue and respect the source.
    b. Include anyone who is impacted by the issue; this is extremely important. All views are critical to completely solve the issue successfully.
    c. Stress that success can only be realized if all participants are engaged, thus everyone needs to fully participate.
4. Explain issue or project to be discussed, including costs or timelines if previously determined. Ensure that an opportunity is presented for anyone to comment or ask questions.
    a. A complete list of the issues and impacts is extremely important.
    b. Data/information needs and uses are extremely important (utilize Appendix B-5 to facilitate the discussion).
        i. What data/information is missing or needed?
        ii. What is the timely source(s) of that data (see B-5)?
        iii. How can it be acquired?
        iv. Is a signed Memorandum of Understanding needed between all parties concerning the use and protections of shared data
    c. Identify any further data required to define the problem and the party responsible for obtaining the data:
        i. Historical weather impact, if applicable.
        ii. Schedule of operations or demand changes.
    d. Determine impact of deadline nonconformance.

5. Further definition of the project or process:
    a. Definition—after reviewing the impact and data/information needed, is the problem correctly defined?
    b. Were all appropriate/impacted entities (not necessarily restricted to airport tenants) included?
    c. Are any sub-teams needed for specific purposes?
6. Solution and idea solicitation. The objective is to start forming agenda items for the next meeting.
    a. What ideas need to be explored?
    b. How do we share information among participants?
7. Determine and capture action items for the next meeting.
8. Establish the date and time of the next meeting.

NOTE: Subsequent meeting agendas should be about the same length and will evolve from developing solutions and plans to address the project or issue.

Appendix B-5: Data Needs Worksheet

This purpose of this worksheet is to assist the ACDM participants in determining the source of information that could be used in an ACDM endeavor. From the first installation of surface surveillance to flight operators in Memphis in 2004, availability of real-time data to adjust to real-time operational situations has been shown as an indispensable element. General categories and their possible sources of real-time information are shown below. It should be noted that all capabilities are not available at every airport, but the worksheet is provided to promote a thorough review.

	FAA NEGS (SWIM)	Operator Pilot	ADS-B Reception	Ramp Tower Or Local Ops	Airline Ops Center	FAA ATCT	FAA ARTCC	FAA ATCSCC	CDM Net	TSA/ CBP	Other Airports	Internet Subscription
Surface Surveillance	✓ For ASDE-X & ASSC sites		✓ Requires aircraft equipage mandated in 2020			✓						
Departure Readiness				✓	✓	✓ Limited			✓ Operator Submitted EOBT			
Traffic Management Restrictions		✓ Limited		✓ Limited	✓	✓	✓	✓	✓			
OOOI	Off & On only	✓	✓	✓	✓	Off, On, & Movement Area entry			Off and On only			
Passenger clearing wait times & staffing										✓		
Passenger throughput at CBP/TSA	✓ Aircraft ETA				✓ Passenger numbers	✓ Aircraft ETA	✓		✓ Aircraft ETA			
De-Ice Times		✓		✓								

	FAA NEGS (SWIM)	Operator Pilot	ADS-B Reception	Ramp Tower Or Local Ops	Airline Ops Center	FAA ATCT	FAA ARTCC	FAA ATCSCC	CDM Net	TSA/ CBP	Other Airports	Internet Subscription
Diversion Info	✓ Limited				✓	✓	✓ Limited	✓ Limited	✓		✓	
Weather RVR						✓			✓			
Weather ITWS						✓	✓					✓
Weather CIWS							✓	✓				✓
Weather Lightning							✓					✓

Appendix B-6: Performance Expectations Worksheet

An important part of the ACDM effort is the determination of metrics for success. These metrics need to be determined after the solution or action is determined. Metrics can range from completion of expected actions from entities involved, compliance to expected actions, completion of milestones, transitions to different phases of the project, etc. Performance measurement is an important part of the ACDM process and should be reported at all subsequent meetings after the first meeting. These reports not only illustrate success but also create accountability and quantify the benefits for ACDM involvement in future projects. Areas for consideration include the following:

- Timeline conformance of assigned reports or operational actions.
- Provision of data sharing among participants.
- Compliance to operational assignments or plans.
- Community outreach accomplishments.
- Budget conformance.
- Meeting attendance.
- Meeting length.
- Timely meeting recap or notes.

Appendix B-7: Final Stakeholder Feedback Worksheet

An important element of collaboration is to understand the needs, attitudes, and concerns of all stakeholders. To that end, it is important to collect and share data on stakeholder impressions of the progress of an ACDM project. This worksheet is designed to collect feedback after the implementation of an ACDM solution and to improve the next application.

1. Please rate the initial ACDM planning process that led to this implementation.

☐ Very ineffective	☐ Moderately ineffective	☐ Neither effective nor ineffective	☐ Moderately effective	☐ Very effective

Comments:

____

____

____

2. Please rate the inclusiveness of the ACDM planning process, in terms of including all relevant viewpoints, providing weight to those viewpoints, and overall fairness.

☐ Very exclusive	☐ Moderately exclusive	☐ Neither inclusive nor exclusive	☐ Moderately inclusive	☐ Very inclusive

Comments:

____

____

____

3. How have implementation costs for your organization compared to expectations?

☐ Much less than expected	☐ Less than expected	☐ As expected	☐ More than expected	☐ Much more than expected

Comments:

____

____

____

4. How has your actual workload related to this ACDM project compared against pre-implementation expectations?

☐ Much less than expected	☐ Less than expected	☐ As expected	☐ More than expected	☐ Much more than expected

Comments:

____

____

____

5. Has the problem initially identified been "solved" by this ACDM project?

☐ Yes	☐ No

Comments:

____

____

____

6. Please list three improvements that could be made to the ACDM **solution** that has been implemented.

a. ____

b. ____

c. ____

7. Please list three improvements that could be made to the ACDM **process** that was used to reach the current implementation state.
   a. ______________________________
   b. ______________________________
   c. ______________________________

APPENDIX C

JFK International Airport Departure Metering

During the summer months of 2010, the PANYNJ planned to close JFK's runway 13R/31L for reconstruction. Due to several events during the previous year with multi-hour taxi-out delays at JFK, the FAA, PANYNJ, and the flight operators were concerned about the impact to air traffic movements during the construction period. In addition, there was particular sensitivity to lengthy delays given the recent implementation of FAA's "Tarmac Rule" where flight operators became subject to significant fines for taxi-out delays exceeding 3 hours.

The PANYNJ held meetings with the flight operators and FAA local, regional, and Air Traffic Control System Command Center representatives to discuss possible mitigation of delays during this construction period. The PANYNJ and flight operators decided that a departure metering function needed to be established to estimate and generate a virtual queue for departure flights. The objective was to absorb expected delays at aircraft parking positions (or designated holding areas if gate availability was an issue). Thus, delays would be absorbed with engines off until a departure was allocated a slot in the virtual queue. Additionally, an orderly and controlled flow of departure traffic from the parking positions/gates would reduce air traffic controller workload and result in a more efficient operation. The virtual queue was determined by a software tool developed and deployed for centralized departure metering under contract to the PANYNJ. Each flight operator would input expected flight departure times into the software and the central metering function would assign a pushback time that would ensure an efficient flow to the runway. This was accomplished in advance so that loading of the flight to conform with the assigned pushback time could be achieved, thus almost eliminating any concern about tarmac rules violations.

This project was not officially labeled as an Airport CDM project, but almost all flight operators at JFK had extensive experience in CDM. Additionally, the PANYNJ requested advice from European ACDM airports that had experience in departure metering. Their advice to the PANYNJ was that meetings about such an operation could not be held too often and that these meetings produced effective participation.

Many meetings were held concerning the implementation of this departure metering because flight operators knew that departure capacity would be reduced and wanted to ensure that their operations received the least delay possible. After implementation, weekly meetings were held to gather feedback and to report on the effectiveness and accuracy of the system as well as the accuracy of the input data from each operator. There was significant concern about accuracy of operator input data and possible "gaming" of the system. This latter concern was eliminated by utilizing the CDM technique of sharing, in real time, everyone's data input and system outputs and employing a neutral slot allocation manager. This type of data sharing had never been previously attempted between flight operators at any U.S. airport because it provided all flight operators with a real-time picture of their competitors' flight departure planning. Once this "transparent" sharing occurred, flight operator input quality improved.

The difference between this project and full ACDM was that the FAA was not a direct participant in the central ground metering function and that the metering function did not have access to FAA air traffic management information. The FAA benefited by the result of this collaboration, but the PANYNJ and the flight operators were responsible for an effective metering operation.

The success of this program has been studied by multiple research organizations, each of which confirmed empirically that significant operational benefits were realized, and at reasonably low cost. Two studies at MIT (Nakahara et al. 2011; Stroiney et al. 2013) estimated the annualized benefits of this system at JFK as reducing taxi out times by 14,800–21,000 hours; reducing fuel burn by 3.26–4.98 million gallons of fuel; and reducing CO_2 emissions by 32,000–47,800 metric tons.

The true testament to the success of the project is that the original duration of the metering was only going to be during the construction. Once the flight operators saw the success, they requested the PANYNJ to establish a permanent metering function.

Abbreviations and acronyms used without definitions in TRB publications:

A4A	Airlines for America
AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation

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