Nationaal Lucht- en Ruimtevaartlaboratorium
National Aerospace Laboratory NLR

Executive summary

A CDM Standard to Guide Implementation in Europe

Problem area
Collaborative Decision Making (CDM) has been identified as an important enabler to increase efficiency of airport operations. CDM addresses the need for operational decisions to be made collaboratively to provide a common situational awareness for ATC, airlines, airports, handlers, and other partners involved.

To support industry in building CDM systems and to ensure seamless integration of these systems in Europe, a EUROCAE working group, WG69, has been established to define a standard for the implementation of CDM at European airports.

Description of work
EUROCAE WG69 has provided a standard which consists of three parts:

- ED-141: Minimum technical specifications.
- ED-145: Interface specifications.
- ED-146: Guidelines for test and validation.

The documents are currently being processed for EUROCAE release.

Results and conclusions
Based on previous work from EUROCONTROL, the standard consists of a number of functional capabilities, which provide a step ward approach towards the implementation of CDM at an airport.

Not all airports need to implement CDM to the full extend. The standard proposed will allow airports to be accredited a CDM airport while implementing CDM exactly to the level they need.

Applicability
The European Commission (EC) issued Mandate 390, which requires the development of a standard for Airport CDM. It has been proposed that CDM implementation becomes compulsory at 139 large and mid size airports in Europe (Airport Capacity Action Plan).

The EUROCAE work is now taken up by ETSI (European Tele-communications Standards Institute) for processing towards this EC standard.

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Author(s)
H.H. Hesselink
J.L. Raoul
D. Bowen

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Nationaal Lucht- en Ruimtevaartlaboratorium, National Aerospace Laboratory NLR

Anthony Fokkerweg 2, 1059 CM Amsterdam,
P.O. Box 90502, 1006 BM Amsterdam, The Netherlands
Telephone +31 20 511 31 13, Fax +31 20 511 32 10, Web site: www.nlr.nl

Nationaal Lucht- en Ruimtevaartlaboratorium
National Aerospace Laboratory NLR

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A CDM Standard to Guide Implementation in Europe

H.H. Hesselink, J.L. Raoul[1] and D. Bowen[2]

[1] NeoMetSys

[2] EUROCAE

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Summary

Collaborative Decision Making (CDM) has been identified as an important enabler to increase efficiency of airport operations. CDM addresses the need for operational decisions to be made collaboratively to provide a common situational awareness for ATC, airlines, airports, handlers and other partners involved.

The Interoperability Regulation (552/2004) [3] of the Single European Sky defines requirements for all ATM systems in Europe. In July 2006, the European Commission issued Mandate 390 [4], which requires the development of a standard (*Community Specification)* for Airport CDM. The Community Specification for Airport CDM will provide a means of compliance against the interoperability regulation of the Single European Sky. It has been proposed that CDM implementation becomes compulsory at 139 large and mid size airports in the Airport Capacity Action Plan [1] under development by the EC.

To support industry in building CDM systems and to ensure seamless integration of these systems in Europe, a EUROCAE[1)] Working Group (WG69) has been established to define a standard for the implementation of CDM at European airports. The standard will consist of three parts:

- Minimum technical specifications of CDM.
- Interface specifications for each of the identified functions.
- Guidelines for test and validation of CDM systems.

The basis for CDM in Europe has been laid in several EUROCONTROL airport CDM projects at e.g. Barcelona, Brussels, and Munich. Not all airports will need to implement CDM to the full extend. The problem that needs to be addressed therefore is to define a standard that will allow airports to be accredited a CDM airport while implementing CDM exactly to the level they need. The task of WG69 therefore was to set up a generic and technical description of CDM. A basis was laid in the specification of capability levels. The capability levels follow the evolutionary nature of CDM systems and allow performance requirements to be specified for each level:

1. Information sharing
2. Collaborative situation assessment
3. Conflict resolution and planning

[1)] EUROCAE is the European aviation standardisation body.

Information sharing is the basic functionality of any CDM system and will need to be implemented at each CDM airport. Information sharing provides access to necessary information at the right time and the right place.

Collaborative situation assessment concerns monitoring of pre-defined milestones and following alerting in case a situation requires so.

Conflict resolution and planning is a level where the system will automatically generate resolutions for identified conflicts and will assist in planning and co-ordination of the airport operations.

This paper will further elaborate the work of EUROCAE WG69, the proposed capability groups, and the following work in specifying interfaces for the CDM system.

Keywords: Collaborative Decision Making, CDM, Airport-CDM, standardisation, airport efficiency

Contents

Abbreviations

A-CDM	Airport Collaborative Decision Making
AGHT	Actual Ground Handling start Time
AIBT	Actual In-Block Time
ALDT	Actual Landing Time
AOBT	Actual Off-Block Time
ANSP	Air Navigation Service Provider
ARDT	Actual Aircraft Ready Time
ASAT	Actual Start-up Approval Time
ASRT	Actual Start up Request Time
ATC	Air Traffic Control
ATOT	Actual Take-Off Time
CDM	Collaborative Decision Making
CFMU	Central Flow Management Unit
CNS	Communication Navigation Surveillance
CS	Community Specification
DPI	Departure Planning Information
EATMP	European Air Traffic Management Programme
EC	European Commission
EIBT	Estimated In-Block Time
ELDT	Estimated Landing Time
EOBT	Estimated Off-Block Time
ER	Essential Requirement
ETA	Estimated Time of Arrival
ETD	Estimated Time of Departure
ETO	Estimated Time Over
ETOT	Expected Take-off Time
ETSI	European Telecommunications Standards Institute
ETTT	Expected Taxi Time
FUM	Flight Update Messages
ICAO	International Civil Aviation Organisation
IR	Implementing Rule
OATA	Overall ATM/CNS Target Architecture
TOBT	Target Off-Block Time
TSAT	Target Start-up Approval Time
WG69	Working Group 69 (EUROCAE Working Group on CDM)

1 Introduction

Collaborative Decision Making (CDM) is generally regarded an important enabler to increase efficiency of airport operations. CDM addresses the need for operational decisions to be made collaboratively to provide a common situational awareness for Air Navigation Service Providers (ANSPs), airlines, airports, handlers, and other partners involved. The parties recognise the need for starting Airport CDM programs (A-CDM). In fact, many airports throughout Europe have a local A-CDM implementation programme and/or an A-CDM working group established. EUROCONTROL intensively supports these programmes and has set up several projects of which the ones in Barcelona, Brussels, and Munich are the most advanced in their implementation until now. This support has led EUROCONTROL to write several high level documents on what A-CDM must provide.

A major step has recently been set by Central Flow Management Unit (CFMU) through the communication of Departure Planning Information (DPIs) and Flight Update Messages (FUMs) [5]. Through these messages, flight information is sent to and from the CFMU, enabling airports, airlines, and ANSPs to better plan their operations.

However, until now, all airports use their own definitions and tools. An ETD (Estimated Time of Departure) or ETA (Estimated Time of Arrival) has no accurate meaning in an international context. Even so, within one airport every operator uses its own meaning of the term, so that communication is hampered severely. The same applies for other information items; it is time to start a co-ordinated approach towards the standardisation of Airport CDM.

This paper will describe the A-CDM concept in chapter 2 and the establishment of a working group to define a standard in the form of a Community Specification for A-CDM in chapter 3. General capabilities, capability levels, and functional groups are described in the following sections. Finally, the implications of the standard are described.

2 Airport CDM

The concept of CDM is an approach to using aeronautical data, based on sharing all data between all partners, ensuring a common view of the ATM and airport operations. CDM addresses the need for operational decisions to be made collaboratively as to provide a contribution to maximising capacity and efficiency. The objective of A-CDM is to ensure the provision of the right information of the right quality to the right system, person, or persons at

the right time. CDM "can bring substantial benefits to the operation of the airport network as a whole if a critical mass of partners participates" [1].

The A-CDM Implementation Manual [8] points out that "To enable the operational use of A-CDM partners' existing systems will have to be adapted at least to a level where they can seamlessly communicate with each other. <…>. The goals are to:

- Improve predictability
- Improve on-time performance
- Reduce ground movement costs
- Optimise/enhance use of ground handling resources
- Optimise/enhance use of stands, gates and terminals
- Optimise the use of the airport infrastructure and reduce congestion
- Reduce wastage of ATFCM slots
- Enable flexible pre-departure planning
- Reduce apron and taxiway congestion."

While the implementation of the A-CDM concept requires first and foremost a change in culture regarding the way that data is used and decisions are made, it nevertheless requires that the A-CDM partners possess certain capabilities or systems that enable them to share data and make and implement decisions collaboratively.

The European A-CDM concept is airport centric. An Airport CDM Task Force has been created at EUROCONTROL. This Task Force provides support to airports in Europe and has set up a basic set of documents that constitutes a good overview of CDM and a basis for standardisation [6][7][8]. These documents start with a glossy *applications guide*, to aid newcomers to the subject in understanding the basic principles of CDM. Next, an *implementation manual* is written, which is a high level overview of the steps to take when implementing CDM. The document refers to organisational and legal matters (like the establishment of a CDM team and a memorandum of understanding) and then helps the implementation team by defining the steps towards CDM systems. The final document contains *functional specifications* which are very helpful for anyone wishing to define an A-CDM system. More documents from EUROCONTROL will follow, such as the operational concept document and a list of possible error messages, however the organisation is not in a position to specify actual products or to define a standard for implementation of any CDM product. EUROCONTROL does offer the possibility to perform an extensive study at any European airport, a so called *gap analysis*, to brief on the current level of an airport's CDM and to identify steps (gaps) that still need to be tackled in order to establish a basis A-CDM.

No two airports are alike as they vary in terms of geography, capacity, and other attributes. Therefore, A-CDM does not imply any particular system or architecture. Because of that, there is a need to provide a common approach to A-CDM to ensure system-wide interoperability.

EUROCONTROL has worked the A-CDM concept out into specific functions that will need to be implemented. The functional groups are:

- Airport CDM Information Sharing
- CDM Turn-Round Process
- Variable Taxi Time Calculation
- Collaborative Pre-departure Sequencing
- Collaborative Management of Flight Updates
- CDM in Adverse Conditions

As an example, we will elaborate here on the Airport CDM Information Sharing function, which is implemented through a so-called *milestones approach*. The milestones approach is a basic A-CDM element that supports the goal of common situational awareness. This is achieved by the creation of a number of milestones when a given flight is activated. Milestones form the basis for all other A-CDM functions and must be a first step in all A-CDM activities at any airport. Milestones are critical events in the progress of a flight, allowing a more accurate prediction of subsequent events. Milestones:

- Facilitate an improvement in the awareness of all airport partners,
- Trigger updates of downstream information,
- Help identify potential delays of the aircraft, triggering re-planning,
- Enable collaborative decisions to be made.

The EUROCONTROL A-CDM Task Force has identified 16 milestones, see the table below.

Table 1 A-CDM Milestones

NUMBER	MILESTONE	TIME REFERENCE
1	ATC Flight Plan Activation	3 hours before EOBT (estimated off block time)
2	EOBT-2hrs	2 hours before EOBT
3	Take off from outstation	ATOT from outstation (actual take off time)
4	Local Radar Update	Varies according to airport

NUMBER	MILESTONE	TIME REFERENCE
5	Final approach	Varies according to airport
6	Landing	ALDT (actual landing time)
7	In-block	AIBT (actual in block time)
8	Ground handling starts	AGHT (actual ground handling start time)
9	TOBT update prior to TSAT issue (target off block time; target start up approval time)	Varies according to airport
10	TSAT Issue	Varies according to airport
11	Boarding starts	Varies according to airport
12	Aircraft ready	ARDT (actual aircraft ready time)
13	Start up request	ASRT (actual start up request time)
14	Start up approved	ASAT (actual start up approval time)
15	Off-block	AOBT (actual off block time)
16	Take Off	ATOT (actual take off time)

Other Milestones can be added according to particular needs and local circumstances. Just as well, milestones may be applied in a slightly different order (like start-up and push-back, which may be combined, depending on the local situation) and can be embedded in an operational concept where iterations are possible.

From the table, it shows that A-CDM is not only concerned with local airport operations, but that the whole process starts at activation of the flight plan or the take-off of an aircraft at the outstation. Further, A-CDM combines the inbound flight with the outbound flight, through the use of the same aircraft.

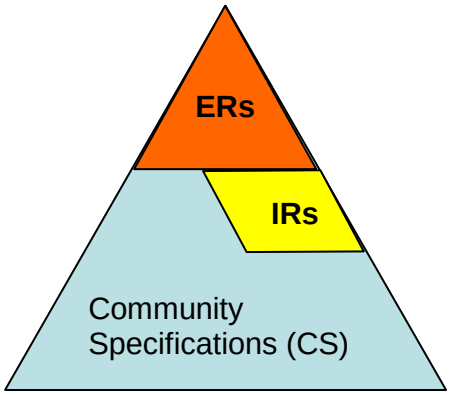
The most important aspect of the table is the use of standard terminology with a given pre-defined meaning. Further elaboration of these terms can be found in [8].

3 Standardisation through a Community Specification

A EUROCAE Working Group, WG69, has been established to define a standard for A-CDM. This WG currently defines a set of documents under the terms of the Single European Sky and the EUROCONTROL European Air Traffic Management Programme (EATMP). EUROCAE WG69 is tasked with identifying relevant standardisation aspects [2] associated with Airport CDM as defined in the EUROCONTROL Airport CDM Implementation Manual.

The work of WG69 is not yet finished, but draft documents are available.

The Interoperability Regulation of Single European Sky (552/2004) [3] defines requirements for all ATM systems in Europe, including the regulatory framework for interoperability of the European ATM system. This includes the mandatory elements of *Essential Requirements* and *Implementing Rules* as well as the voluntary *Community Specifications*, see figure below.



On the basis of this Single European Sky Regulation the European Commission has issued a Mandate (Mandate 390) [4] for the development of standards, in the form of a set of Community Specifications (CS) for Airport CDM. Community Specifications are developed by the European Standards Organisations and are a voluntary means of compliance with the Essential Requirements and any associated Implementing Rules. Compliance with a Community Specification gives a presumption of conformity against the Essential Requirements and any associated Implementing Rules.

The A-CDM Community Specifications will be specified by ETSI, who are just starting this process. ETSI, the European Telecommunications Standards Institute, is one of few institutes in Europe who are in a position to define CSs.

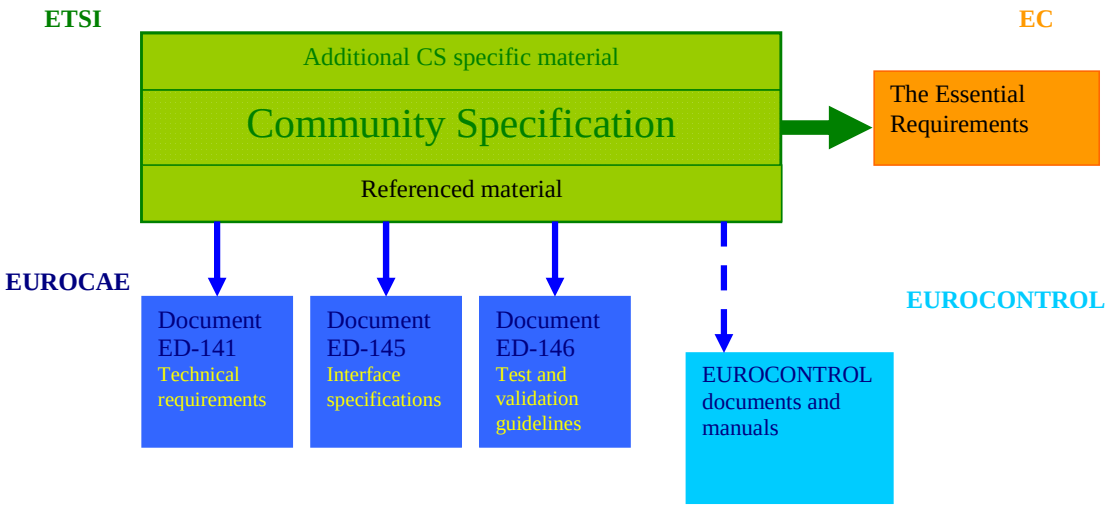
The Community Specification for A-CDM will provide a means of compliance against the interoperability regulation of the Single European Sky. It has been proposed that A-CDM implementation becomes compulsory at 139 large and mid size airports in the Airport Capacity Action Plan [1]. For this, only the seven Essential Requirements have to be met. These are:

- Seamless operation
- Safety
- Civil-military coordination
- Support of new concepts of operation
- Environmental constraints
- Principles governing the logical architecture
- Principles governing the construction of systems

The core technical material of the CS will be provided by reference to the published output of EUROCAE WG 69, which is developing three documents for A-CDM:

- Minimum Technical Specifications (ED-141)
- Interface Specifications(ED-145)
- Test and Validation Document (guidelines) (ED-146)

Reference will also be made to relevant EUROCONTROL and ICAO documents as appropriate see the figure below.



4 Capabilities for A-CDM

EUROCAE Working Group 69 started the work with defining the general A-CDM context in a system approach. These are subdivided into general capabilities and functional capabilities, as described in the following sections.

The WG69 heavily relies on the work that has been carried out by the EUROCONTROL A-CDM Task Force. Further, support is given by other EUROCONTROL projects, like OATA (Overall ATM/CNS Target Architecture), who are defining the ATM/CNS architecture for the year 2011. The OATA work is taking a structural top-down approach towards the definition of co-ordinating functions for the A-CDM partners. This starts with the identification of the operational concept for 2011, followed by division of this into several high-level scenario descriptions [6][10]. Based on these scenarios, use cases are defined that identify specific situations, one at the time. Eventually, this leads to a structure of use cases, which in detail describe the A-CDM operations. This structured approach helps in defining the necessary A-CDM operations and especially to establish the A-CDM interface definitions.

4.1 General Capabilities

General capabilities to be provided by any A-CDM system comprise a number of functional and technical groups. The following System Under Description diagram gives a general impression of the technical context of A-CDM, see Figure 1. The functional groups all are contained in the core management group. Technical groups are depicted around this.

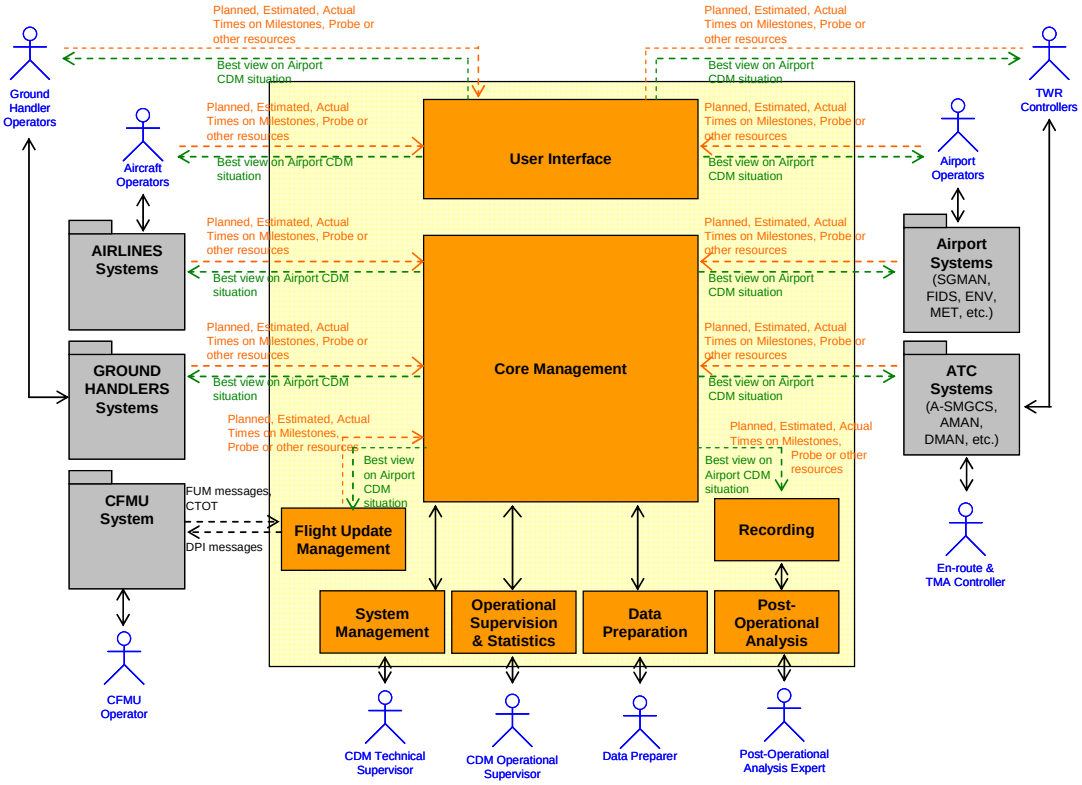


Figure 1 CDM system context and high level internal functions.

Operational Supervision & Statistics

This function is used to oversee and monitor system status and performance, supervise the recovery from malfunctions due to data loss or inconsistency, and manage operational configuration setup and changes. The general philosophy is that appropriately authorised supervisors are allowed to directly adapt the information repository to the operational situation.

System Management

This function is used to start and stop the system, monitor the system and recover from malfunctions due to the failure of system components or communication lines. Additionally this system element defines user access rights, performs operational configuration changes such as assignment of operator roles to working positions, and the uploading of-line system data

Recording

Recording is concerned with the registration of all non-derived information that is entered in the system. The aim of the recording function is to provide the possibility for analysing information off-line.

The recording must be able to identify sources of information, timing of information, system restarts together with software version and parameter settings. It must also register the actions performed by the end users (like log on, log off, and selections/filters being applied by the end users.

Post-Operational Analysis
This function maintains appropriate online metrics that can be used to determine the performance and effectiveness of each operational element. Examples of the type of statistics that could be maintained are:

- All actual times
- All predicted times
- Mean turn-round time
- Mean queue length

Many airports have systems providing this analysis. Such systems can be used to fulfil the requirement for this A-CDM system module.

Data Preparation
The goal of this logical element is to provide off-line parameters to the A-CDM system that can be used to tune it to provide better performance or to rectify problems in the operation of the system. This support function can enable the user to define:

- Source priorities
- Alert parameters
- Parameters to calculate the variable taxi time
- Different types of access, and filtering

Flight Update Management
Flight Update Management is one of the CDM functions as defined by EUROCONTROL and concerns the communication with the CFMU, through sending DPIs and the reception of FUMs. It is identified as a separate technical function here as the task will need to be perform by one point of contact at the airport. Usually, this person is assigned by the ANSP.

4.2 Functional capabilities

The core management function of Figure 1 describes the functional behaviour of the system. A number of capabilities groups that describe the functioning of the system is proposed here. The capabilities build on top of each other, so that an airport can start with the basic capabilities and then incrementally implement more. The following three groups of capabilities are identified.

Information sharing is the basic functionality of any CDM system and will need to be implemented at each CDM airport. Information sharing provides access to necessary information at the right time and the right place.

Collaborative situation assessment concerns monitoring of pre-defined milestones and following alerting in case a situation requires so.

Conflict resolution and planning is a level where the system will automatically generate resolutions for identified conflicts and will assist in planning and co-ordination of the airport operations.

4.2.1 Capability group 1 – Information sharing

Information sharing is the fundamental group for any A-CDM system as it provides access to necessary information at the right time and the right place. Information on estimate times are uncertain by nature in timing and quality of the information. The information sharing capability consists of the following functions:

- User interface
- Data filtering
- Information repository
- Data security
- System management
- Recording

4.2.2 Capability group 2 – Collaborative Situation Assessment

Once information is available from capability group 1, it can be monitored in capability group 2. Everything related to adding new information to the existing is considered in capability group 2. This includes warnings on conflicting information, warnings when information is missing, and the identification of the information with the highest quality. The collaborative situation assessment capability consists of the following functions:

- Milestone monitoring and alert management
- Source priority management
- Post-operational analysis
- Operational supervision and statistics

4.2.3 Capability group 3 – Collaborative resolution and planning

All capabilities of group 2 are assumed to be implemented within group 3. This group concerns the facilities for automated support for solving conflicts and automated planning to match the

capacity with demand. Very little operational systems are available yet within this capability group and therefore, at the moment, it will not be considered in the standard. The collaborative resolution and planning capability consists of the following functions:

- Flight update management
- Conflict resolution support
- Planning and re-planning
- Simulation

Exception to this is the Flight Update Management capability, which is the most important capability in this group at the moment. Flight Update Management concerns the provision of departure planning information (DPI) from the A-CDM system to the CFMU and Flight Update Messages (FUM) from the CFMU to the A-CDM system. The aim is to maintain planning information on the aircraft and to keep the information on current flow regulation consistent between the Aircraft Operator and the CFMU.

A FUM is sent from the CFMU to an A-CDM system and provides an Estimated Landing Time (ELDT), Estimated Time Over (ETO), and Flight Level at the last point of the route. The FUM is sent for all inbound aircraft to enable the possibility to compare the inbound and outbound leg of the flight. An automated comparison between the Estimated In-Block Time (EIBT) and the minimum turn-around time of the inbound flight against the Estimated Off-Block Time (EOBT) of the flight needs to take place.

The DPI message is generated at several times during departure of an aircraft. An update will be sent if the estimated information in the message changes by at least five minutes. The DPI message contains the expected taxi time (ETTT) and the expected take-off time (ETOT) as originated from the Aircraft Operator.

5 What will change for you

In order to comply with the Single European Sky Interoperability regulation, large and mid size airports in Europe will need to implement an A-CDM program, wherewith the implementation of A-CDM cannot be anymore an activity that is set up without reference to the outside world. Compliance with the currently proposed standard will be required.

This means that all parties involved will need to adapt their terminology used to the one that will be described in the standard. This has clear advantages, as for example currently ETD has

no accurate meaning. The now required use of TOBT has a clear, unambiguous definition: *The time that an aircraft operator or handling agent estimates that an aircraft will be ready, all doors closed, boarding bridge removed, push back vehicle available, and ready to start up / push back immediately upon reception of clearance from the TWR.* Ambiguous or local acronyms will become “illegal”; everyone will have to use the same language.

With this, partners will have to provide more information than in the past to support the collaborative process in order to support the milestones approach and the other A-CDM processes.

Concerning the relation with CFMU, there must be one single Point of Contact at an airport to support communicating the new messages FUM and DPI. Communication with CFMU must be established through prescribed means and over prescribed protocols. The connection to CFMU through FUMs and DPIs is now operational in Munich and Brussels and this will be expanded to all airports in Europe.

The standard will have its commercial impact as it will be accepted by industry and open the market for the development of new tools.

6 Concluding: what will be the benefit for you

Most people will recognise that A-CDM brings benefits. The underlying paper is not concerned with general benefits of A-CDM. But what is the benefit of standardising the A-CDM implementation?

Many airport operators, airlines, and ANSPs have heard of CDM. Well attended courses are being organised and most people have seen presentations once or twice. Many airports are interested in implementing A-CDM to a more or lesser extent. Still, when it comes to realising A-CDM procedures or building an A-CDM system, most airports do not know where to start and a lot of effort is needed to find out what A-CDM is and what is can do. The definition of a standard will make the first steps towards A-CDM more concrete and easier to take

Once operational, the A-CDM system will record all airport data of common interest allowing a global analysis of these data. There will be a technical standard for data exchange that everyone will have to follow. This opens possibilities for accuracy measurements and improved planning.

New systems that will be purchased will comply with the standard. For industry, it will become more evident what to build and equipment in line with the standard will be easier to sell. For airports, it will be easier to understand what to buy. This will imply a cost reduction for all parties.

The now proposed EUROCAE standards ED-141, ED-145, and ED-146 will help to harmonise the operational procedures all over Europe. Enhanced decision making capabilities through information sharing amongst all airport partners brings many quantitative and qualitative benefits to the operation of not only individual airports but more importantly for the airport network [1]. This way, the co-ordinated local approach benefits Europe as a whole.

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