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Manual on Flight and Flow — Information for a Collaborative Environment (FF-ICE)

Approved by the Secretary General
and published under his authority

First Edition — 2012

International Civil Aviation Organization

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AMENDMENTS

Amendments are announced in the supplements to the *Catalogue of ICAO Publications*; the Catalogue and its supplements are available on the ICAO website at www.icao.int. The space below is provided to keep a record of such amendments.

RECORD OF AMENDMENTS AND CORRIGENDA

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FOREWORD

The air transport industry plays a major role in world economic activity and must maintain a safe, secure, efficient and environmentally sustainable air navigation system at global, regional and local levels. In order to achieve this, implementation of an air traffic management (ATM) system is required to promote maximum use of enhanced capabilities provided by technical advances.

Future ATM requires a collaborative environment with extensive information content.

The purpose of this manual is to present a concept for the Flight and Flow — Information for a Collaborative Environment (FF-ICE) to be implemented by 2025. This manual has been developed with particular attention on achieving the vision outlined in the *Global Air Traffic Management Operational Concept* (Doc 9854) and with meeting the requirements outlined in the *Manual on Air Traffic Management System Requirements* (Doc 9882).

The FF-ICE concept illustrates information for flow management, flight planning, and trajectory management associated with ATM operational components. It will be used by the ATM community as the basis for which ICAO Standards and Recommended Practices (SARPs) will be developed in order to ensure that the FF-ICE concept can be implemented globally and in a consistent manner.

Future developments

Comments on this manual would be appreciated from all parties involved in the development and implementation of FF-ICE. These comments should be addressed to:

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GLOSSARY

ACRONYMS

<i>Acronym</i>	<i>Expansion</i>	<i>Comment</i>
4DT	4 dimensional trajectory	Usually referred to as “4D trajectory”
AI	Aeronautical information	
AIXM	Aeronautical information exchange model	
AMHS	Aeronautical message handling service	
ANSP	Air navigation service provider	Subset of ATM service provider
AO	Aerodrome operations	From <i>Global ATM Operational Concept</i> Is not aircraft operator (in this manual)
AOM	Airspace organization and management	From <i>Global ATM Operational Concept</i>
AOP	Aerodrome operator	<i>Note.</i> — “Operator” not “operations”.
AP	Airspace provider	From <i>Global ATM Operational Concept</i>
ARO	Air traffic services reporting office	
ASP	ATM service provider	From <i>Global ATM Operational Concept</i>
ATM	Air traffic management	
ATMRPP	Air Traffic Management Requirements and Performance Panel	
ATS	Air traffic services	
AU	Airspace user	From <i>Global ATM Operational Concept</i>
AUO	Airspace user operations	From <i>Global ATM Operational Concept</i>
CAS	Calibrated airspeed	
CDM	Collaborative decision-making	From <i>Global ATM Operational Concept</i>
CM	Conflict management	From <i>Global ATM Operational Concept</i>
DCB	Demand and capacity balancing	From <i>Global ATM Operational Concept</i>
DTD	Document type definitions	
ESB	Enterprise service bus	

Acronym	Expansion	Comment
ESP	Emergency service provider	
FF-ICE	Flight and Flow — Information for a Collaborative Environment (FF-ICE)	
FPL	Flight plan	
FOC	Flight operations centre	
FPLSG	Flight Plan Study Group	
GUFID	Globally unique flight identifier	
ICE	Information for a collaborative environment	
KPA	Key performance areas	
PBA	Performance-based approach	
POE	Point of entry	
QoS	Quality of service	
RPAS	Remote piloted aircraft system	
RTA	Required time of arrival	
SAR	Search and rescue	
SDM	Service delivery management	From <i>Global ATM Operational Concept</i> (ATM-SDM)
SUA	Special use airspace	
SWIM	System-wide information management	
TBD	To be defined	
TFM	Traffic flow management	
TMI	Traffic management initiative	
TOD	Top of descent	
TS	Traffic synchronization	From <i>Global ATM Operational Concept</i>
XML	Extensible markup language	
XSD	XML schema definition	

DEFINITIONS

4D trajectory — A four-dimensional (x, y, z, and time) trajectory of an aircraft from gate-to-gate, at the level of fidelity required for attaining the agreed ATM system performance levels.

Agreed 4D trajectory — The current 4D trajectory that is agreed between the airspace user and the ASP after collaboration, or imposition of pre-collaborated rules.

Explanation: The agreed trajectory is the trajectory that the airspace user agrees to fly. There is only one agreed 4D trajectory for any given flight at any time. As the ATM system has unpredictable or uncontrollable events and to allow flexibility, it is likely that it will be necessary to renegotiate trajectories. The agreed 4D trajectory therefore reflects the most recent instance (that is the current) agreement.

Aircraft trajectory — The aircraft trajectory is the trajectory that the aircraft intends to fly (and has flown).

Expected use: The aircraft trajectory is always what the aircraft is intending to fly or has flown. It is not necessarily the agreed trajectory. In normal operations, it is expected that the aircraft trajectory will remain with the trajectory tolerances of the agreed trajectory.

Airspace user trajectory constraint — Airspace user's trajectory constraint on the acceptable solutions.

ATM community — See the *Global Air Traffic Management Operational Concept* (Doc 9854).

ATM trajectory constraint — Trajectory constraint imposed by the ATM system.

Coordinated airport — Any airport where, in order to land or take off, it is necessary for an aircraft operator to have been allocated a slot by an appropriate authority.

Desired 4D trajectory — The current 4D trajectory that is requested and generated by the airspace user with knowledge of the ATM system's operational constraints and resource contention.

Explanation: The airspace user determines the trajectory that is best suited to meet their mission objectives. The airspace user may elect to preemptively circumvent operational constraints and resource contention — or engage in collaboration on the trajectory. There is only one desired 4D trajectory for any given flight at any time. To allow for flexibility and as the ATM system has unpredictable or uncontrollable events, it is likely that it will be necessary to renegotiate trajectories. The desired 4D trajectory therefore reflects the most recent request. Where the agreed 4D trajectory is not the desired 4D trajectory then the ASP will seek to provide the desired 4D trajectory as soon as possible. This has a corresponding requirement on the airspace user to ensure that the desired 4D trajectory is kept updated.

Emergency service provider — Provider of emergency services, such as search and rescue organizations.

Executed 4D trajectory — The actual 4D trajectory of the aircraft from the start-up to the present position.

Explanation: The executed 4D trajectory is what was executed and is not necessarily the desired or agreed 4D trajectories. The executed trajectory relates only to the current flight of the aircraft (and does not contain information from previous flights, even with an en-route to en-route perspective). The executed 4D trajectory information can be used for performance and operational analysis.

Flight and Flow — Information for a Collaborative Environment (FF-ICE) — Flight and flow information necessary for notification, management and coordination of flights between members of the ATM community within the collaborative environment envisioned in the Global ATM Operational Concept.

FF-ICE can refer to a single instance (an individual flight) and also to an aggregation of flights (each with their own flight information in FF-ICE).

Gate-to-gate — Considers the operation of an aircraft not just from take-off to touchdown (the airborne segment) but from the first movement with intention of flight to completion of movement after flight; that is from the gate (or stand or parking position) to gate (or stand or parking position).

Globally unique flight identifier (GUFI) — A single reference for FF-ICE information pertinent to a flight that is unique globally.

Information for a collaborative environment (ICE) — Information necessary to enable the collaborative environment envisioned in the Global ATM Operational Concept. It contains, but is not limited to, information domains such as flight and flow information, aeronautical information and surveillance information.

Negotiating 4D trajectory — A 4D trajectory proposed by airspace user or ASP as a potential agreed 4D trajectory.

Explanation: For trajectory negotiation purposes, multiple trajectories may be required during the negotiation process; however, each participant would be allowed only one negotiating 4D trajectory at a time which represents their most recent proposal in the negotiation. These trajectories may not necessarily be a gate-to-gate trajectory. These trajectories are intended to be transitory.

Ranked 4D trajectories — A series of desired 4D trajectories, with tolerances supplied if necessary by the airspace user to define when the next ranked trajectory should be used.

Explanation: Ranked 4D trajectories are not mandatory. However, there can be ATM system performance benefits in some circumstances. Tolerances are used to express the bounds of variation on the trajectory triggering a preference for the next ranked trajectory.

Note.— This could also be written so that ASP can use ranked trajectories in a similar manner.

Regional extensions — FF-ICE will be based upon global information standards defining a core set of data. Regional extensions on data elements are permitted in accordance with harmonized global practices for defining and referring to these elements.

Explanation: The global information standard for the FF-ICE will be defined through published XML schemas under version control and maintained by ICAO. If operationally needed and viable, regional extensions to the information standard may be considered. These regional extensions would then also be published as regional XML schemas with version control. As information is provided, use of different namespaces can allow valid schemas from multiple regions to be unambiguously referred to in a single XML message. Regional extensions cannot be created for data already defined within global FF-ICE that are from any other region already registered with ICAO.

Regional variation required for performance reasons will be implemented by use of different subsets of the standard information elements. New elements will be introduced regionally as needed, but will not be mandatory for other regions, will not provide duplicate information of existing elements, and should be intended to become part of the global standard. A formal process will be introduced for migrating successful new elements into the standard.

Regional requirement — Regional requirements specify conditions regarding data items within a region if necessary.

Explanation: For example, a Quality of Service requirement.

Trajectory update requirement — The trajectory update requirement specifies displacement values that require an aircraft, when it is displaced by at least one of these values from the last trajectory advised to ATM, to provide updated trajectory information to the ATM system.

Expected use: In order to minimize data exchange bandwidth, it is not expected that every change to an aircraft's trajectory is communicated by the aircraft to the ATM system; instead, only those changes of a particular displacement need to be communicated. These values include longitudinal, lateral, and vertical displacements; time (estimate) and speed changes may be included as well. An update does not necessarily mean that a new agreed trajectory is required as the aircraft may be operating within the agreed trajectory tolerances. The update requirement values are set depending on the need of the ATM system to monitor the aircraft's progress and are therefore related to surveillance. An example use is to monitor trends; for example, if the aircraft is progressively operating towards the limit of its existing agreed trajectory tolerances. Another possible use is when new constraints need to be imposed, then the aircraft trajectory rather than the agreed trajectory (which could be a significant difference when there are large trajectory tolerances) could be taken into consideration. It is expected that the FF-ICE aircraft trajectory will be initialized to the agreed trajectory and so the first aircraft trajectory update will be displacement from the agreed trajectory, but would then be based on the last advised aircraft trajectory.

Consideration: The update is currently defined as an event when a specific displacement is achieved. It is not a requirement to update at particular time intervals. The definition will need to change if it is expected that "routine" reports are required. Another consideration is if other aspects of the trajectory should also be subject to update requirements.

REFERENCES

ICAO documents

Annex 2 — *Rules of the Air*

Annex 3 — *Meteorological Service for International Air Navigation*

Annex 4 — *Aeronautical Charts*

Annex 11 — *Air Traffic Services*

Annex 15 — *Aeronautical Information Services*

Procedures for Air Navigation Services — Air Traffic Management (PANS-ATM, Doc 4444)

Manual on Air Navigation Services Economics (Doc 9161)

Performance-based Navigation (PBN) Manual (Doc 9613)

Global Air Traffic Management Operational Concept (Doc 9854)

Safety Management Manual (SMM) (Doc 9859)

Manual on Air Traffic Management System Requirements (Doc 9882)

Manual on Global Performance of the Air Navigation System (Doc 9883)



Chapter 1

INTRODUCTION

1.1 PURPOSE/OBJECTIVE

1.1.1 As part of the ATM service delivery management (SDM) component, the Air Traffic Management Requirements and Performance Panel (ATMRPP) proposed a mechanism to succeed the present-day ICAO flight plan which shall be developed to enable the realization of the Operational Concept.

1.1.2 The FF-ICE takes into consideration the requirements of the ATM community, including the military, to achieve a “common picture” in global ATM. The focus on cooperation should be, in particular, in the areas of data security, data exchange, data integrity, and data sharing.

1.2 SCOPE

1.2.1 This manual, while focused on the FF-ICE concept, includes guidance material on the high-level process by which information is provided, the operational and technical environment within which the FF-ICE is expected to operate, and considerations for transition to the FF-ICE. As this concept is intended to support the vision articulated in the *Global ATM Operational Concept*, this manual is written with the expectation that the operational environment will be performance-based and will meet the eleven ATM community expectations defined in Appendix D of the *Global Air Traffic Management Operational Concept* (Doc 9854).

1.2.2 The FF-ICE is limited to flight information-sharing between members of the ATM community. It starts with the early submission of flight information by the airspace users to the ATM system and ends with archiving the relevant information after the flight. It concentrates on global needs for sharing flight information but also accommodates regional and local needs.

1.2.3 The FF-ICE supports all the ATM Operational Concept components requiring flight information (demand and capacity balancing (DCB), conflict management (CM), service delivery management (SDM), airspace organization and management (AOM), aerodrome operations (AO), traffic synchronization (TS), airspace user operations (AUO)) and refines the *Global ATM Operational Concept* in the area of flight information management. It constitutes the necessary basis for the most advanced ATM systems and the development of four-dimensional (4D) trajectory management.

1.2.4 The FF-ICE constitutes only one information domain of the ICE. The FF-ICE represents the evolution of today's flight plan towards flight-specific information and processes required to support the *Global ATM Operational Concept*. The FF-ICE will use and supply information to other information domains such as: aeronautical information, meteorological information, and surveillance data.

1.2.5 The FF-ICE concept addresses the following topics:

a) provision and sharing of information between authorized members of the ATM community, which includes:

1) aircraft and flight identification, including aircraft capabilities;

- 2) airspace user intent and preferences for each flight;
 - 3) information necessary to support search and rescue (SAR); and
 - 4) information supporting access requirements;
- b) the life cycle and intended use of the above information;
- c) the mechanisms supporting the exchange/sharing of FF-ICE information between members of the ATM community; and
- d) assumptions on the surrounding information environment.

1.3 STRUCTURE OF THIS MANUAL

1.3.1 Subsequent to this introduction, this manual is organized as follows:

Chapter 2: Drivers for Change presents the motivation behind the development of a new concept for the FF-ICE.

Chapter 3: The FF-ICE Concept describes the FF-ICE, the main principles and concepts and how they operate in a global environment by describing the participants, the milestones, and the mechanisms.

Chapter 4: The Technical Environment provides a detailed list of information elements, the system-wide environment used for information-sharing and the supporting infrastructure.

Chapter 5: Transition describes how the transition from the present situation could occur, taking into account the performance objectives of the different participants and regions.

1.3.2 Appendices include additional detailed material in several areas:

Appendix A: FF-ICE Information Elements describes candidate information elements for exchange.

Appendix B: Operational Transition describes additional considerations for transition to the FF-ICE from the present-day system.

Appendix C: Operational Scenarios details the information exchanges that occur to achieve certain activities in the FF-ICE environment.

Appendix D: Understanding the Trajectory describes how trajectories are described within the FF-ICE concept.

Appendix E: Information Hierarchy provides an example hierarchy and XML schema description of the information elements presented in Appendix A.

Appendix F: System-wide information management (SWIM) illustrates high-level properties of information management in a SWIM environment discussed during the development of the FF-ICE concept.

1.4 RELATIONSHIP TO OTHER DOCUMENTS

1.4.1 The *Global Air Traffic Management Operational Concept* (Doc 9854) presents the ICAO vision of an integrated, harmonized, and globally interoperable ATM system. The FF-ICE describes the information environment in support of that vision. The key aspects include support for a performance-based approach (PBA), collaborative decision-making (CDM), system-wide information management (SWIM) by trajectory.

1.4.2 The vision described in the *Global ATM Operational Concept* led to the development of ATM system requirements as specified in the *Manual on Air Traffic Management System Requirements* (Doc 9882). The FF-ICE concept has been aligned with Doc 9882 by ensuring that the system-wide information environment meets the system requirements.

1.4.3 The ICAO *Manual on Global Performance of the Air Navigation System* (Doc 9883) provides guidance on implementing a PBA consistent with the vision of a performance-oriented ATM system. The FF-ICE concept provides the necessary flexibility to implement a PBA and also considers the information requirements in support of performance evaluation. It is anticipated that implementation of the FF-ICE concept will follow the PBA principles.

1.4.4 Implementation of FF-ICE will impact a broad set of ICAO provisions, including Annex 2 — *Rules of the Air*, Annex 3 — *Meteorological Service for International Air Navigation*, Annex 4 — *Aeronautical Charts*, Annex 11 — *Air Traffic Services* and Annex 15 — *Aeronautical Information Services*, and the *Procedures for Air Navigation Services — Air Traffic Management* (PANS-ATM, Doc 4444). Modifications to these documents in order to develop and implement the FF-ICE will be proposed in the next phase of work of the Air Traffic Management Requirements and Performance Panel (ATMRPP).

1.5 CONVENTIONS USED IN THIS MANUAL

This manual follows the conventions itemized below:

- a) document and section titles are italicized;
- b) quotations are italicized and inside quotation marks; and
- c) additional clarifying information or references to additional information are presented in italics and a chevron (➤) itemizing the list.

Chapter 2

DRIVERS FOR CHANGE

2.1 INTRODUCTION

2.1.1 The present-day ICAO flight planning provisions were developed on the basis of a manual, paper-based, point-to-point, teletype communications system. A fundamental change is required to support the implementation of the vision described in Doc 9854, including its advanced performance management processes — even though some elements have been addressed within existing flight planning provisions.

2.1.2 The vision of a performance-based ATM system can only be actualized using performance management and flexibility requirements to support performance-driven changes (see 2.2).

2.1.3 The *Global ATM Operational Concept* has greater data requirements than can be supported by the existing flight planning provisions. These include system-wide information-sharing, providing early intent data, management by trajectory, CDM, and high automation support requiring machine readability and unambiguous information (see 2.4).

2.1.4 Doc 9882 identifies requirements that must be supported by the FF-ICE. Some of the high-level requirements are identified in 2.3.

2.1.5 While it is recognized that the transition to the FF-ICE will involve significant operational and financial considerations, there would also be significant consequences associated with inaction or delay. The expected growth and dynamism in air transportation, together with the need for improved performance, makes it necessary to implement the *Global ATM Operational Concept* as soon as possible.

2.2 PERFORMANCE FOCUS

2.2.1 The notion of a performance-based air navigation system emanated from good industry practices that have evolved over many years outside of aviation. The benefits that organizations within the ATM community can expect are:

- a) improvement in the effectiveness of day-to-day economic management of their business;
- b) a channeling of their efforts towards better meeting stakeholder expectations (including safety) as well as improving customer satisfaction; and
- c) change-management in a dynamic environment.

2.2.2 The desire to evolve towards a performance-based air navigation system is reflected in relevant ICAO documentation listed below.

2.2.3 Performance is a recurring theme in the *Global ATM Operational Concept*:

- a) the vision statement is expressed in terms of safety, economic cost-effectiveness, environmental sustainability, security, and interoperability;

- b) the definition of ATM makes explicit reference to safety, economic aspects, and efficiency; and
- c) the ATM community expectations are listed under eleven performance-related headings: access and equity, capacity, cost-effectiveness, efficiency, environment, flexibility, global interoperability, participation by the ATM community, predictability, safety, and security.

2.2.4 In Doc 9883, the eleven ATM community expectations have been used to define the eleven ICAO key performance areas (KPAs) which serve as the global, top-level categorization framework for the performance measurement taxonomy.

2.2.5 Doc 9882 contains system requirements related to each of these eleven KPAs, as well as a number of general performance-oriented requirements. These notably include requirements to:

- a) ensure that performance targets are defined, regularly reviewed, and monitored;
- b) establish interchange of global benchmarking performance data as a cornerstone of management;
- c) ensure that all information for performance management is available and transparent to the concerned parties and that information disclosure rules are in place; and
- d) ensure that any performance management system establishes rules for performance measurement, performance maintenance, performance management, and performance enhancement.

2.2.6 Other ICAO documents also advocate a PBA in their respective areas of applicability. Such documents include the *Manual on Air Navigation Services Economics* (Doc 9161), the *Safety Management Manual (SMM)* (Doc 9859), and the *Performance-based Navigation (PBN) Manual* (Doc 9613).

2.2.7 The *Manual on Global Performance of the Air Navigation System* (Doc 9883) outlines the basic, universal principles present in any PBA, as follows:

- a) strong focus on desired/required results through adoption of performance objectives and targets;
- b) informed decision-making, driven by the desired/required results;
- c) reliance on facts and data for decision-making; and
- d) monitoring resulting performance to check whether decisions had the right effect and to trigger corrective action where required.

2.2.8 Doc 9883 goes on to provide detailed guidance and suggestions on how to deploy and apply the performance-based approach. In particular, it draws the attention of the reader to the fact that the principles outlined above can successfully be applied in a wide variety of contexts as summarized below.

2.2.9 Use at a wide variety of levels of detail or aggregation:

- a) from an operational perspective: managing performance of parts of operations (e.g. for individual flight phases of a particular flight), individual operations (e.g. gate-to-gate performance of individual flights), or the aggregate of operations (e.g. for optimizing the collective performance of groups of flights);
- b) from a time-period perspective: at the level of momentary performance (real time) or more aggregated at the level of hourly, daily, weekly, monthly, quarterly, seasonal, annual, or multi-year performance results;

- c) from a geographical perspective: at the level of local performance (e.g. individual airports, local airspace volumes, or States), regional performance, or global performance; and
- d) from a stakeholder aggregation perspective: at the level of individual operational units/entities (e.g. specific ATM facilities), individual stakeholder organizations (e.g. specific air navigation service providers [ANSP]), or stakeholder segments (e.g. collective performance of ANSP groups or all ANSPs).

2.2.10 Use of the PBA at different levels of management:

- a) policy-making (through definition of strategic objectives, targets, incentives, etc.);
- b) regulation (in terms of required performance rather than required solutions);
- c) transition planning (planning changes to the system);
- d) system design and validation (developing changes to the system);
- e) day-to-day economic management;
- f) day-to-day operational management (delivery of ATM services); and
- g) continuous improvement (monitoring and optimizing the system over time).

2.2.11 None of the activities in the above list can solely be responsible for delivering the ATM performance which is ultimately achieved for the total set of flights managed by the ATM system. It is the careful coordination of all these activities which will result in meeting all the agreed performance targets. Good ATM performance is an essential ingredient for the success of the members of the ATM community, with corresponding impact on society's performance expectations.

2.3 THE FF-ICE AS A CORNERSTONE OF THE PERFORMANCE-BASED AIR NAVIGATION SYSTEM

2.3.1 All of the above is relevant to the FF-ICE concept. Flight information and associated trajectories are a principal mechanism through which ATM service delivery meets day-to-day operational performance. It follows that, in a performance-based air navigation system, the FF-ICE:

- a) contains many of the facts and data in support of performance-based decision-making;
- b) contains data representing the result of performance-based decision-making;
- c) contains data related to managing the performance of a particular individual flight; and
- d) contains data related to managing overall performance and meeting overall expectations.

This implies that:

- e) from a bottom-up performance monitoring perspective, FF-ICE data from individual flights will often be combined to represent a measure of aggregate performance and to check whether the more general performance targets are met;

.....

- f) from a top-down performance management perspective, operational decisions affecting individual flights (hence changing the content of individual FF-ICE data objects) will often be taken based on performance objectives, targets and trade-off criteria defined at a wider (multi-flight) scope; and
- g) the data provide mechanisms for ensuring consistency, interoperability and persistence;

which enable an evaluation of end-to-end ATM system performance that:

- h) provides increased flexibility with regard to new requirements and enables:
 - 1) the meeting of changing performance objectives stemming from evolving societal expectations; and
 - 2) the implementation of future performance-based decisions.

2.3.2 It is clear from the above that the FF-ICE concept will be a cornerstone in future ATM performance management. It will have global applicability and must therefore be able to support the performance management activities of all members of the ATM community whether they are using the most simple or the most advanced processes, tools, and solutions.

2.3.3 Performance management is a continuous process with strategic, tactical, and forensic activities occurring over several years. The FF-ICE provides information and mechanisms to support these activities, such as:

Long-term performance management — looks ahead many years to set feasible objectives and targets and anticipate levels of performance. Where necessary, evidence-based planned improvements are proposed to meet targets. The FF-ICE information supports this activity by providing archived data that can be used for such functions as trend analysis, validation, forecasting, and model improvement. Furthermore, planned improvement may require the flexibility offered by the FF-ICE should future information needs grow.

Pre-tactical performance management — looks forward, within a year before departure, to conduct such planning activities as short-term capacity management. These activities are highly collaborative, with airspace users providing information through the FF-ICE regarding planned operations and capabilities, and their levels of performance.

Tactical performance management — is conducted on the day of operation, with airspace users, airports, and ANSPs using planning tools to optimize their own operations in a collaborative environment. The collaboration and optimization is supported through sharing information on operational constraints, preferences, and trajectories.

Performance monitoring — occurs throughout the flight life cycle, allowing real time and post-event assessment of the ATM system performance. This process provides a control mechanism on the largely predictive performance management aspects. The FF-ICE supports performance monitoring in a variety of manners, such as:

Quality of service assessment — In some KPAs (efficiency, flexibility, predictability), performance is defined as the difference between the flight as flown and a certain baseline for the flight. What needs to be measured and managed are changes and trade-offs made during the (collaborative) planning process and the extent to which ATM can facilitate optimum flight operations as defined by the performance needs of each individual airspace user. In order to support these KPAs, the FF-ICE will need to archive a number of trajectories representing performance and the evolution of the plan as a result of the collaborative planning process.

End-to-end performance assessment — Performance of the ATM system is characterized by many interrelated procedures and processes (also known as “dependencies”). The FF-ICE provides mechanisms to have a single consistent set of information pertaining to each flight from which end-to-end performance can be obtained.

En-route to en-route performance — In many cases, the (collaborative) ATM processing of a flight does not end at the moment that the aircraft arrives on-blocks (e.g. stops at the gate). For instance, as part of performance management, there may be seamless integration with turn-around management, charging (i.e. payments due), incident investigation, etc. The FF-ICE information is available for use by these processes.

2.3.4 For detailed guidance on how to apply the PBA by planning through implementation and operation, the reader is directed to Doc 9883.

2.4 ADDRESSING CURRENT LIMITATIONS

2.4.1 The present-day flight planning provisions have important limitations. These limitations are described in this section together with a summary of how the FF-ICE concept will address them.

Sharing flight information — Currently, the means for sharing flight plan information between service providers and airspace users relies on multiple two-party message exchanges in the form of: a filed flight plan (FPL), repetitive flight plan, current flight plan, estimate messages, voice coordination, air traffic services inter-facility data communication messages, air-ground data communication and online data interchange messages. With increased CDM, information exchange will increase and involve more than just the present participants. A concept is required that creates a globally harmonized method for sharing information before and during flight.

- *The FF-ICE will provide the ability to share the same flight information across a broad range of collaborating participants before and during a flight.¹*
- *The FF-ICE will replace all existing data message formats between ATM community members about flight intent and flight progression.*
- *The information about the flight will be available from the time of first notification of the flight intent until after the flight has completed, at which time the information will be archived.*

Advance notification — Currently, intention of flight can only be supplied a short time before flight (variations up to 120 hours in advance of flight). However, it is possible for airline passengers to book a seat on a flight up to a year in advance, and therefore, the ATM system could be made aware of the intended operation. At some locations, efficient ATM operations require more notice than just a couple of days, and a concept is required that allows long-term notification of flights (for example, up to a year in advance). Note that it is recognized that only some types of operations can provide long-term notification of operations and that not every detail of the flight is required in the long-term notification.

- *The airspace user will be able to notify flight intent up to a year in advance. Details will be able to be progressively supplied (as information becomes reliable enough to communicate).*
- *Mandatory requirements for data and requirements for submission are balanced to enhance flexibility and ensure reliability of information — however, airspace users will be encouraged to supply information as soon as it becomes reliable enough to be useful to assist in ATM planning. Service providers will be reminded to consider all performance areas, including flexibility to accommodate infrequent subsequent changes that appear to be in good faith.*

1. As described in 1.5, additional clarifying information or references to additional information are presented in italics with a chevron (➤) itemizing the list.

2.4.2 Another aspect of advance notification is that some information is currently only communicated to service providers when voice contact is established with the appropriate unit (e.g. approach requirements). The strategic approach of the *Global ATM Operational Concept* will require methods for earlier notification of requirements or preferences.

- *The FF-ICE provides the ability for notification by the airspace user of preferences. This information can be supplied earlier to all authorized parties.*

Inconsistent flight information — Currently, determining the status or version of a flight plan requires reception and correct processing of the original FPL and all subsequent modification messages (such as change messages [CHG], departure messages [DEP], etc.). Sometimes there is more than one version of the FPL sent (that is, instead of using CHG messages, a complete replacement is sent). None of these messages have version or sequence information, and often the messages are sent from origin to each service provider individually, and so adjacent service providers may have different information if they were to compare information. A concept is required that ensures that all who have access to the FPL information use the same information for a flight.

- *On the first notification of flight intent, a globally unique flight identifier (GUFI) will be created that will allow all (with appropriate access rights) to view or modify information related to the same flight.*

Information distribution — The original method of information distribution for an FPL was by submitting a paper FPL at an Air Traffic Services Reporting Office for dissemination to relevant service providers. This was largely conducted through a system of peer-to-peer communications using protocols developed for teletype machines. Many service providers now provide mechanisms for airspace users to directly communicate FPLs to them, with some providers requiring that the airspace user is responsible for notifying each provider (Flight Information Regions) independently. A concept is required that ensures a globally consistent method of distribution of information.

- *In the end-state, the FF-ICE provides a globally consistent mechanism and consistent interface for providing and receiving flight and flow (FF) information.*
- *The FF-ICE concept recognizes that performance considerations may result in some users not being able to participate at the same level of information-sharing. Thus, for an extended time there will be “pockets” of SWIM capabilities. Consideration is given to how advanced SWIM capabilities can be maximized even with areas that have not yet enabled advanced SWIM capabilities.*
- *While FF-ICE must, by definition, impose requirements on how flight and flow information are communicated between ATM community members, these requirements are limited to the interface, and thus should not impose any restriction on how they individually store and process their data internally or mandate the use of any particular data model (such as a specific flight object).*

Information security — Whether for commercial sensitivities or aviation security purposes, there is a need for increased information security. For example, an airline may be willing to share information with a service provider to permit an improved level of performance of the ATM system, but would be unwilling for that same information to be available to all airspace users.

- *The FF-ICE exchange mechanisms support layered information security.*

Flexible information set — Attempts to accommodate changing information needs at global, regional, and state levels resulted in use of ICAO flight plan Item 18 which was inefficient. There were problems with inconsistent requirements, lack of global definitions, problems with automation processing, etc. There needs to be flexibility so that new data elements can be included and information no longer relevant deleted. Inefficient constraints, such as fixed data lengths or free-text information, should be minimized. A concept that ensures that updates to flight information formats are done in a globally efficient manner is required.

- *The FF-ICE supports unambiguous information versions validated against a published standard. Changes to the FF information can be specified in new versions of the standard while standard practices ensure that formats are adhered to. Backward compatibility between different versions allows interoperability between ATM community members without requiring coordinated transitions.*
- *The FF-ICE data description provides flexibility in information formats. Field lengths can be expanded in future versions to support current requirements. Valid field list items, such as aircraft types, can be managed in a globally consistent manner.*

Derivable information — The *Global ATM Operational Concept* describes an information management system that ensures not only the integrity and consistency of information but eliminates the need for re-entry if the data are already available to the ATM system. The current flight plan contains multiple instances of information that can be derived from other information elements. FPL originators have to provide elements that could be obtained elsewhere. When information is derived by different ASPs, such as trajectories used by automation, there is no process to guarantee the consistency of this derived information.

- *FF-ICE data formats support automation-to-automation interactions, enabling derived information to be generated at the source.*
- *The FF-ICE supports the provision of information services to ensure consistency of derived information.*

2.5 MEETING THE ATM SYSTEM REQUIREMENTS

2.5.1 The FF-ICE concept covers the process for submission, dissemination, and use of flight and flow data within the future ATM system and therefore acts as an enabler for many of the requirements identified by the *Global ATM Operational Concept*.

2.5.2 This enabling function of the FF-ICE concept is summarized in Appendix A (Tables A-1 to A-12), where data elements foreseen for the FF-ICE are identified. The last column, “ATM system requirements”, refers to the requirements listed in Doc 9882, Appendix A, to which the FF-ICE data elements provide support, and Doc 9882 itself provides a reference for each requirement to the corresponding paragraphs of Doc 9854 from which it has been derived.

2.5.3 Although Appendix A of this manual has detailed references to the requirements in Doc 9882, some example requirements listed in the manual which are relevant to the new functionality made available by the FF-ICE are identified in Table 2-1.

Table 2-1. Example requirements for FF-ICE

<i>ATM requirement number (Doc 9882)</i>	<i>Requirement</i>	<i>OCD Reference (Doc 9854)</i>
R07	Ensure that the airspace user makes relevant operational information available to the ATM system	2.1.6 c)
R09	Use relevant data to dynamically optimize 4D trajectory planning and operation	2.1.6 d)

<i>ATM requirement number (Doc 9882)</i>	<i>Requirement</i>	<i>OCD Reference (Doc 9854)</i>
R11	Ensure mutual exchange of relevant and timely data: — for the benefit of situational awareness; — for conflict-free trajectory management; and — to allow CDM concerning consequences of airspace user system design changes	2.1.6 b) & 2.6.7 a)
R15	Ensure that airspace users are included in all aspects of airspace management via the collaborative decision-making process	2.2.1
R18	Manage all airspace and, where necessary, shall be responsible for amending priorities relating to access and equity that may have been established for particular volumes of airspace. Where such authority is exercised, it shall be subject to rules or procedures established through CDM	2.2.9
R27	Ensure that flight parameters and aircraft performance characteristics are available to the ATM system	2.3.9 & 2.5.6 d)
R36	a) Utilize historical and forecast weather information, including seasonal patterns and major weather phenomena; b) Use information on changes in infrastructure status to increase predictability and maximize capacity utilization to meet performance targets; c) Ensure collaboration on post-event analysis to support strategic planning; d) Utilize projected traffic demand and planned trajectories; e) Accommodate revisions to trajectory requests and resource status; f) Ensure collaboration on projections and responses; g) Facilitate collaboration on trajectory changes and traffic demands	2.4.3
R49	Provide benefits commensurate with the level of aircraft capabilities or performance	2.6.5
R54	Utilize relevant airspace user operational information to meet performance targets	2.6.7 b)
R62	Select the applicable separation modes and separation minima for CM that best meet the ATM system performance targets	2.7.2

<i>ATM requirement number (Doc 9882)</i>	<i>Requirement</i>	<i>OCD Reference (Doc 9854)</i>
R151	Demonstrate an increased responsiveness across the spectrum of ATM services to real time changes in airspace users' needs. Furthermore, the ATM system should provide the user with at least one alternative in case of changes imposed by the ATM system	2.8.2
R177	Ensure that aircraft capabilities will be totally integrated into the collaborative decision-making process of the ATM community and will allow it to comply with all relevant ATM system requirements	2.1.6 f)
R181	Implement and operate in such a way that the varying and diverse user requirements will be met as closely as technically possible within the defined equity and access	2.4.2 & 2.6.8

2.6 BENEFITS AND COSTS

2.6.1 The *Manual on Global Performance of the Air Navigation System* (Doc 9883) advocates that costs and benefits be addressed at the level of operational improvement; arguably, it is not FF-ICE on its own that will deliver the operational improvements, but only when used in conjunction with other processes still to be developed further, such as CDM and SDM. This manual does not provide a quantification of the costs and benefits to be derived from the adoption and implementation of FF-ICE.

2.6.2 As advocated by Doc 9883, members of the ATM community will work — at local, regional, and global levels — to develop transition road maps. These road maps are composed of specific operational improvements, selected and sequenced to address performance gaps with respect to objectives and targets derived from the ATM community expectations. Guidelines in Doc 9883 further advocate that these road maps be validated by a system-wide performance case, from which the overall benefit of these operational improvements, enabled by FF-ICE, will mature (refer to Doc 9883).

Chapter 3

THE FF-ICE CONCEPT

3.1 INTRODUCTION

The FF-ICE concept is detailed below:

Principles — These are derived from *The Global ATM Operational Concept* and address the previously identified limitations.

Participants — Reinforce that the FF-ICE concept will require the interaction of multiple participants in a collaborative environment.

Overall collaborative environment — Describes the information environment within which the FF-ICE is expected to operate.

Timeline for FF-ICE information provision — Indicates that the flight information process begins up to a year before departure and continues through completion of the planned flight until archiving.

Scheduled flight scenario — An example of the flight information process is provided to help the reader.

Formation flights — The example of formation flights is provided to clarify how these are to be treated in the FF-ICE.

Volume of airspace operations — Indicates the possible need for operations within a volume of airspace distinct from trajectory operations.

3.2 PRINCIPLES

3.2.1 The FF-ICE is guided by the requirement to eliminate or reduce the limitations of the present Flight Plan and to accommodate the future environment detailed in the *Global Air Traffic Management Operational Concept* (Doc 9854).

3.2.2 The principles of the FF-ICE can be summarized as follows:

- a) provide a flexible concept that allows new technologies and procedures to be incorporated as necessary in a planned manner. This flexibility should also consider the effects of evolving information and communications standards;
- b) allow aircraft to indicate their detailed performance capabilities, such as the required navigation performance (RNP) level;
- c) allow for an early indication of intent;

- d) incorporate information for increased and more automated CDM;
- e) avoid unnecessary limitations on information;
- f) support 4D management by trajectory;
- g) avoid the filing of unnecessary and ambiguous derivable information; adopt a “file-by-exception” philosophy when information cannot be standardized;
- h) allow for the provision of information security requirements;
- i) consider the cost impact on providers and consumers of flight information;
- j) incorporate requirements enabling a broad set of flight mission profiles;
- k) ensure information is machine-readable and limit the need for free-text information; and
- l) ensure that definitions of information elements for the FF-ICE are globally standardized.

3.2.3 Regional variation required for performance reasons will be implemented by using different subsets of the standard information elements. New elements will be introduced regionally, through regional extensions as needed, but will not be mandatory for other regions, will not provide duplicate information of existing elements, and should be intended to become part of the global standard. A formal process will be introduced for migrating successful new elements into the standard information.

3.3 PARTICIPANTS

3.3.1 A future collaborative and dynamic flight information process requires the interaction of multiple participants in the ATM community. This list of participants is significantly extended from present-day flight planning as the process described herein begins a year prior to departure and extends until completion of the planned flight and archiving.

3.3.2 A summary of the key high-level participants and roles is described below. Except for the emergency service provider, the other terms are mentioned and/or described in detail in the Doc 9854, Appendix A.

Airspace users (AU) — The term airspace users mainly refers to the organizations operating aircraft and their pilots. For this manual, we emphasize that airspace users include the flight operations centres (FOC) responsible for the strategic planning of a flight and the entity responsible for the execution of a flight which is traditionally a flight deck.

Aerodrome operators (AOPs) — Participating aerodrome operators include the operators of the departure, arrival, alternate, and any other aerodromes requiring or providing information for planning purposes. As per the *Global ATM Operational Concept*, aerodrome operators are a part of the aerodrome community.

ATM service providers (ASPs) — There are many ATM services provided to an airspace user, from the earliest strategic planning through the completion of a flight. Entities providing service or potentially providing service to an airspace user can require or provide information. These can include the ANSP within which the flight departs, transits, or arrives, in addition to an ANSP where the flight is expected to transit an area of interest.

Airspace providers (APs) — Flights transiting airspace may require permission from an airspace provider. This term is described in the *Global ATM Operational Concept* as a role, traditionally the responsibility of Contracting States, which has undergone some evolution.

Emergency service providers (ESPs) — One important reason for providing flight information is to support the provision of emergency services in the event of such an occurrence. Providers of these services require that certain information be available.

3.4 OVERALL COLLABORATIVE ENVIRONMENT

3.4.1 The FF-ICE concept provides a globally harmonized process for planning and providing consistent flight information. Local design decisions may dictate that the underlying mechanisms for communicating flight information may not be identical; however, these mechanisms must be compatible across boundaries and capable of exchanging required information during all phases of flight planning.

3.4.2 The FF-ICE will be based on a globally consistent and unambiguous set of information elements. Providing consistent information does not imply that information requirements will be identical globally. While the definition of flight information will be standardized globally, the FF-ICE will contain some data elements that are required in one region and not in others. Practically, this implies a need for an infrastructure to support the transport and dissemination of this information.

3.4.3 In addition, not all information elements are required for all flights depending on desired performance levels.

3.4.4 With regard to the management of the information in Doc 9854, in paragraph 2.9 some key objectives that the future flight planning environment must also adhere to are described, such as:

- a) information must be shared on a system-wide basis (Doc 9854, 2.9.5);
- b) pertinent information will be available when and where it is required (Doc 9854, 2.9.6);
- c) information may be personalized, filtered, and accessed, as needed. The initial quality of the information will be the responsibility of the originator; subsequent handling will not compromise its quality (Doc 9854, 2.9.8);
- d) information-sharing can be adjusted to mitigate any proprietary concerns (Doc 9854, 2.9.9); and
- e) information management will use globally harmonized information attributes (Doc 9854, 2.9.11).

3.4.5 Authority to access and enter information items will be controlled in accordance with a set of rules known to the ATM community. Users may have access to a subset of information within the FF-ICE. These access rights are not static and may change as a function of time or status of the flight/system. Rules will also depend on the specific instance of the FF-ICE (e.g. one airspace user may not alter other users' information).

3.4.6 Once the FF-ICE is created, all interested and authorized parties will have access to the information it contains. One service may provide information upon request; another service may provide updates as the information changes. These updates will be based upon specified criteria. These criteria may require notification that a flight is no longer applicable should the flight information change.

3.4.7 It is expected that, for making changes to information, access rights to each part of the flight information will be determined based upon the authority that each user has, given the state of the flight. Mechanisms will be in place (e.g. data "ownership") to manage information updates from multiple authorized parties. User profiles will be applied to define default behavior for access, authorization, and subscription to information.

3.5 ELEMENTS OF THE ICE

3.5.1 This manual focuses on the flight and flow information within the future collaborative environment. This concept makes assumptions regarding additional information constructs interacting with the FF-ICE. Figure 3-1 illustrates the overall environment and the highest-level interactions. Participants are expected to provide and consume shared information, subject to tailored information requirements, to deliver the concept component functionality.

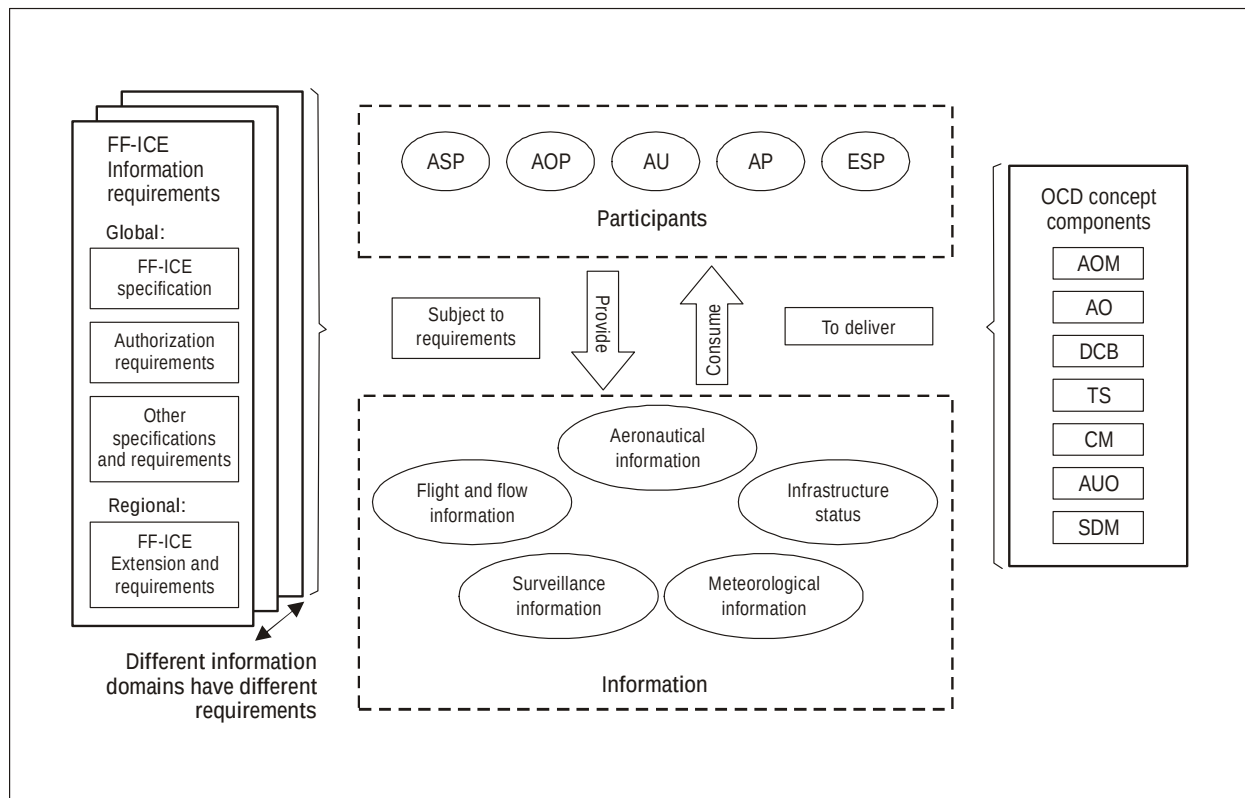


Figure 3-1. Information is used and provided by participants, subject to information requirements, to deliver the concept component functions

3.5.2 Information attributes and definitions will be globally harmonized with some regional extensions as permitted in 3.2. For performance reasons, different information elements will be required under different circumstances, locations, and times. The required set of information elements and conditions on providing information will be specified in requirements. Both global and regional requirements will exist. As an example, one region may require airport slot information for coordinated airports at some time before estimated off-block time (EOBT). A mechanism will be in place to ensure, through automated means, that information requirements are complied with. Compliance with requirements may be real time (e.g. information item is provided by a specified time) or post-analysis (e.g. early intent information meets accuracy requirements).

3.5.3 The airspace user is one participant that provides and updates flight information. The user also receives or obtains ASP-issued modifications to that information. There will be requirements on the information that must be provided, and there may be requirements on aircraft performance/capabilities. The airspace user will be able to obtain these requirements and ensure compliance. In some areas, these requirements may be dynamic, with a correspondingly dynamic and automated mechanism for obtaining requirements.

3.5.4 In order to perform many of the activities required to achieve the vision in the *Global ATM Operational Concept*, flight and flow information must interact with aeronautical information to deliver certain services required by multiple members of the ATM community. Not all services will be required by all members of the ATM community and all services will not be provided by all ASPs.

3.5.5 Figures 3-2 through 3-5 illustrate a few interactions. These interactions are described below:

- a) flight information will refer to aeronautical information (e.g. this could be expressed in Aeronautical Information Exchange Model [AIXM] format). This includes static information such as runways, airports, and fixed boundaries. Aeronautical information can also be dynamic as described below. In the long-term, it is expected that all aeronautical information will be managed to support dynamic data;
- b) AOM allows the dynamic definition of airspace constructs such as airspace volumes and routes. This will be dynamically reflected in aeronautical information. These must be shared in such a way that flight information can reference the dynamic data and verify that flights meet required constraints;
- c) DCB requires the ability to communicate resource limitations (capacity) such that projected resource utilization (demand) can be evaluated. Capacity-limited resources are expressed within aeronautical information, and the dynamic capacity figures must be defined for these resources. This information must allow a proposed flight to be evaluated to determine whether it contributes to demand/capacity imbalances. The evaluation of a flight against congestion may include the probability of the flight encountering congestion. This evaluation can be conducted by the airspace user;
- d) capacity will be impacted by the operational status of systems and infrastructure. The ATM system requires the capacity impacts to be expressed in a manner consistent with aeronautical information;
- e) AUO will face requirements on performance and/or approved capabilities, both static and dynamic. Some of these requirements are expected to be linked to aeronautical information. For example, certain airspace volumes or routes (where defined) will require levels of navigation performance. A mechanism must exist to specify and disseminate these requirements. These requirements may also be altered as a result of AOM activities or weather conditions; and
- f) specifications on providing required information for the FF-ICE will also be expressed using aeronautical information. For example, levels of precision required for trajectory information provision can be dynamic and dependent on airspace constructs such as routing. Requirements may also vary regionally based upon circumstances and desired performance levels.

3.5.6 Planning of AUOs and AOs requires knowledge of meteorological conditions (e.g. winds, convective activity, instrument conditions). Meteorological conditions also impact the capacity of shared resources that must be incorporated into tactical DCB. A shared situational awareness of meteorological information and the projected impact this will have on capacity is expected in the future collaborative environment. This situation is illustrated in Figure 3-3.

3.5.7 Trajectory synchronization activities obtain flight information and provide constraints onto the flight trajectory to achieve flow objectives and to conduct strategic CM. Trajectory synchronization must consider the totality of the ATM situation including dynamic aeronautical and meteorological information, and infrastructure status, as shown in Figure 3-4.

3.5.8 Separation provision activities will be conducted by the designated separator, which may be an ASP or the airspace user. In a trajectory-based environment, this activity operates on the 4D trajectory supplied as part of the flight information, supplemented with up-to-date surveillance information. Separation provision must also consider the overall ATM situation, including dynamic aeronautical and meteorological information, and infrastructure status, as shown in Figure 3-5.

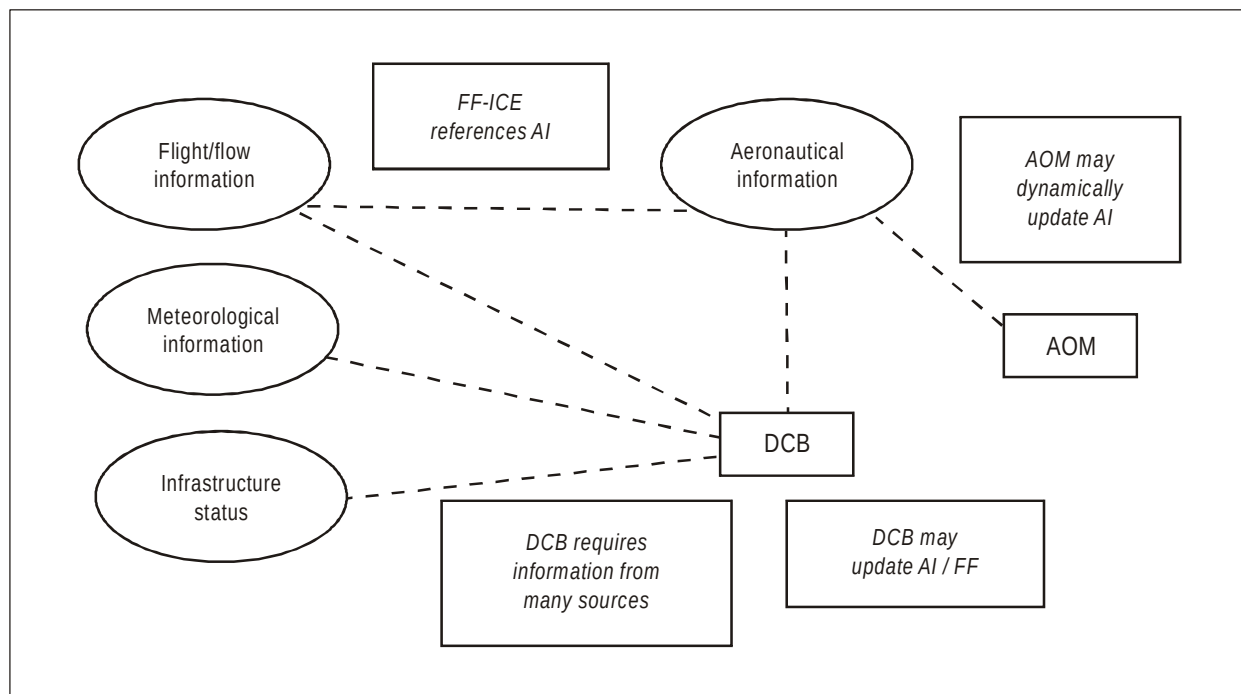


Figure 3-2. Example dependencies between information and delivery of demand/capacity balancing and airspace organization and management concept components

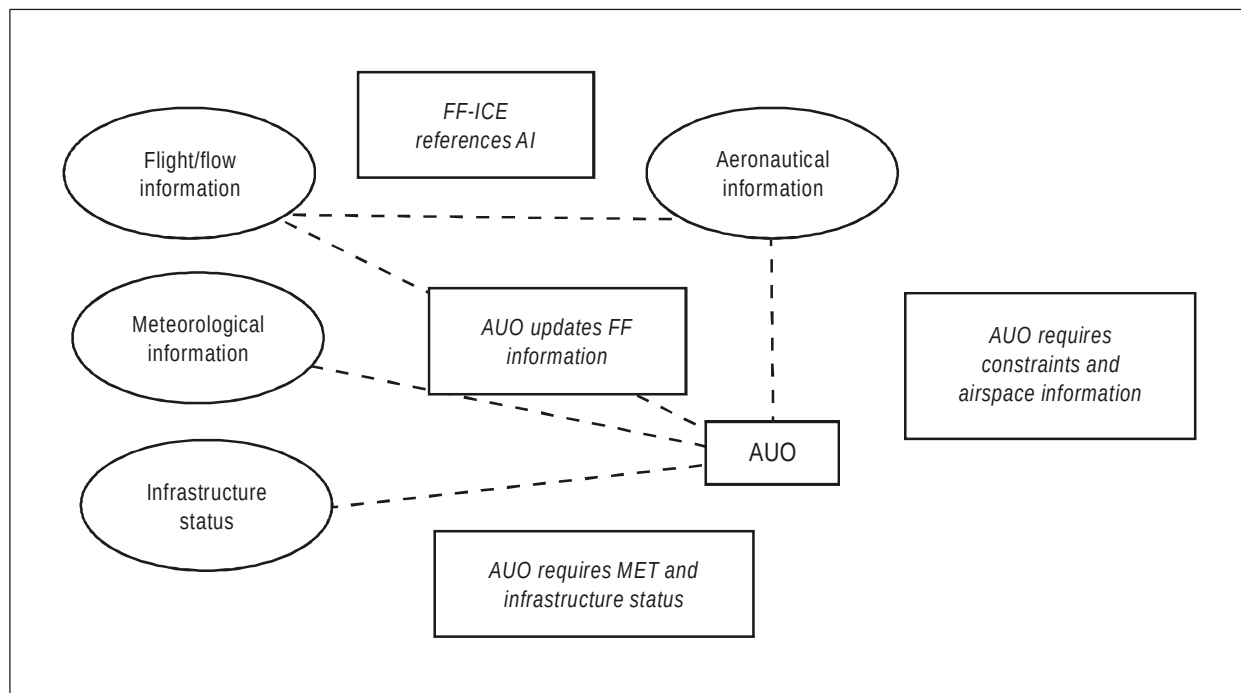


Figure 3-3. Example dependencies between information and delivery of airspace user operations concept component

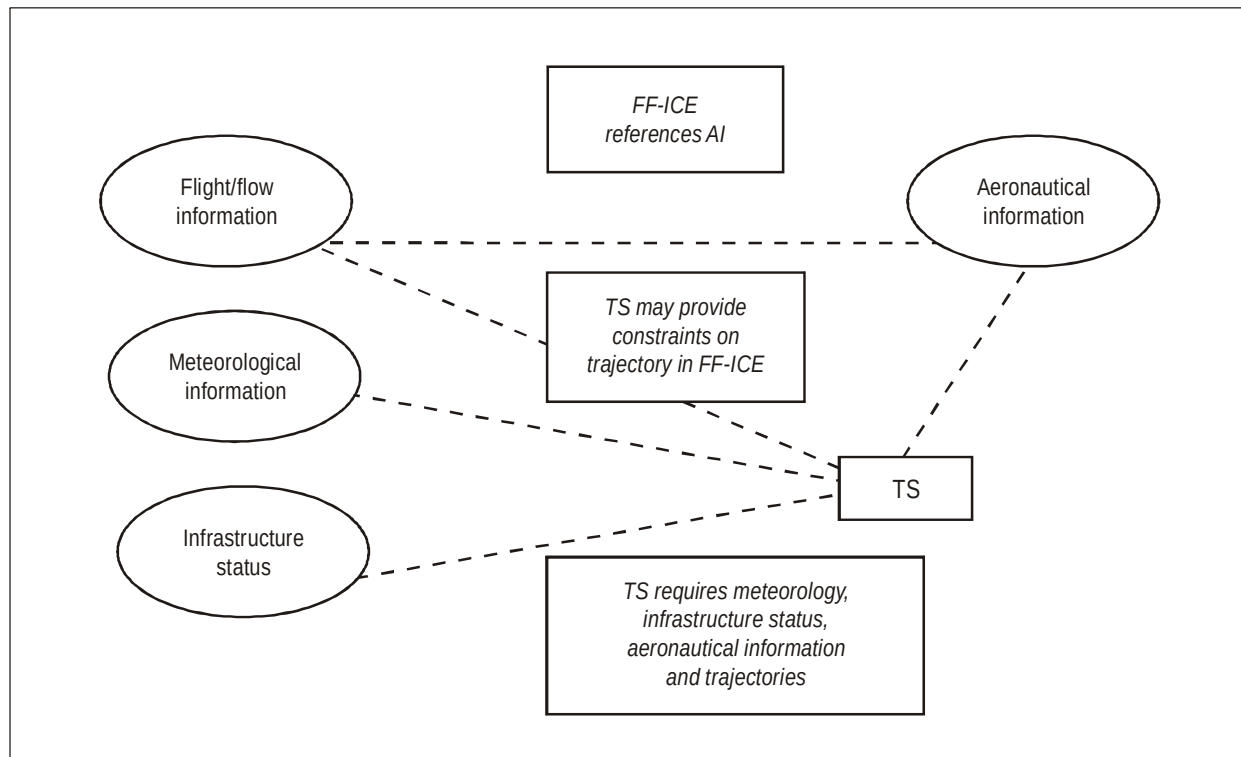


Figure 3-4. Example dependencies between information and delivery of traffic synchronization concept component

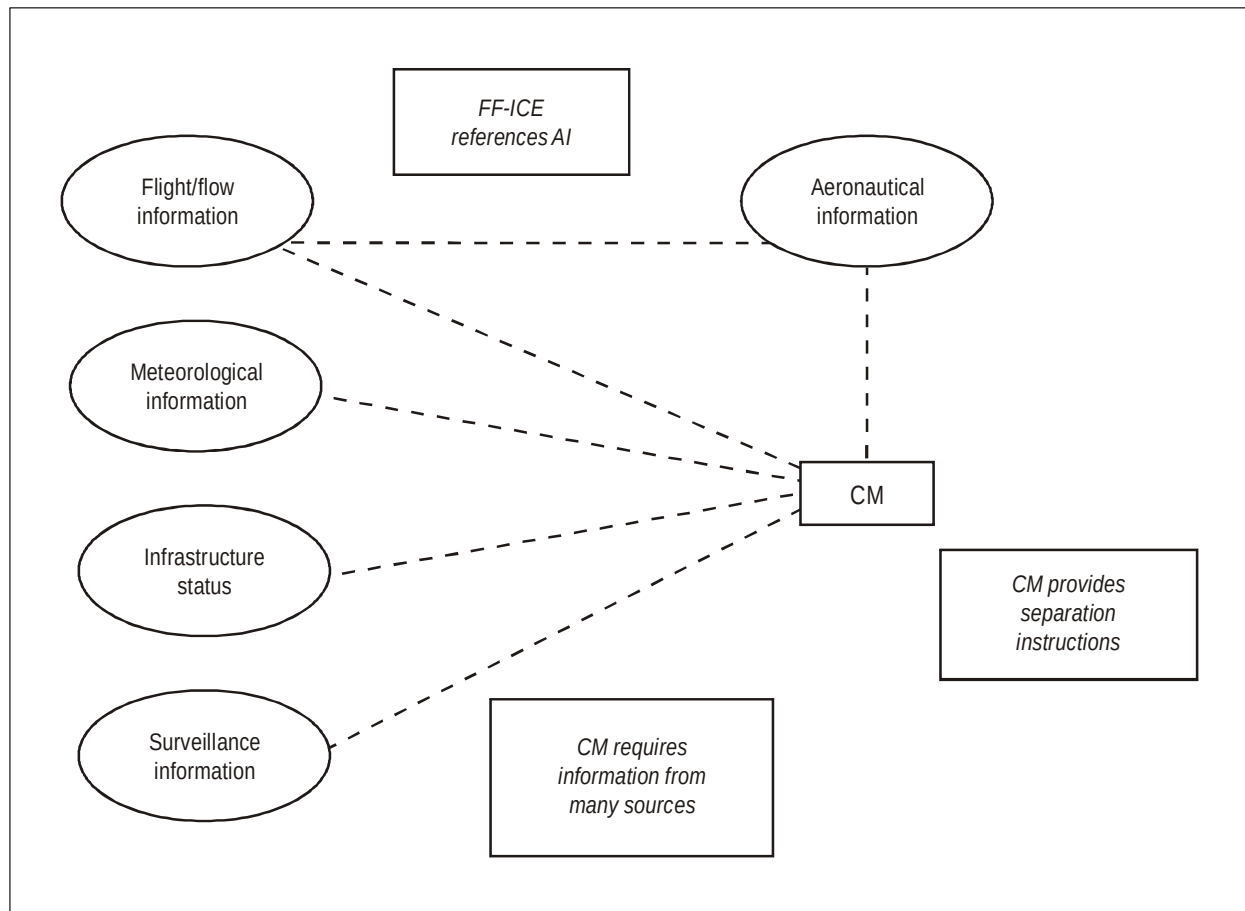


Figure 3-5. Example dependencies between information and delivery of conflict management concept component

3.6 TIMELINE FOR FF-ICE INFORMATION PROVISION

3.6.1 In the future, providing flight information for planning purposes will be a more ongoing process relative to the present day. Whereas currently an aircraft operator may file a single FPL form, in the future, the operator will provide further information about a flight as time approaches departure and throughout the flight. Some of this information is known ahead of time with relative certainty (e.g. departure and arrival airport), other information will be better known closer to departure (e.g. route of flight, estimated time en-route), and some could change dynamically throughout the flight (e.g. estimated time of departure, agreed trajectory).

3.6.2 Since the flight information process is expected to be ongoing, requirements for the provision of information will be event-driven. These can include certain events such as: the availability of a significant piece of data, such as meteorological information, a fixed time before scheduled pushback, a time prior to entry into airspace, the issuance of a clearance, or a change in responsibility. One example of an information provision requirement would be that before departure, the airspace user shall supply information necessary for the provision of emergency services.

3.6.3 Throughout the flight information process, various participants will interact with the FF-ICE. The participants will change along the flight information provision timeline with more strategic functions (DCB) being involved earlier and more tactical functions (e.g. TS and CM) later. Figure 3-6 illustrates the types of activities relative to the events affecting a single flight.

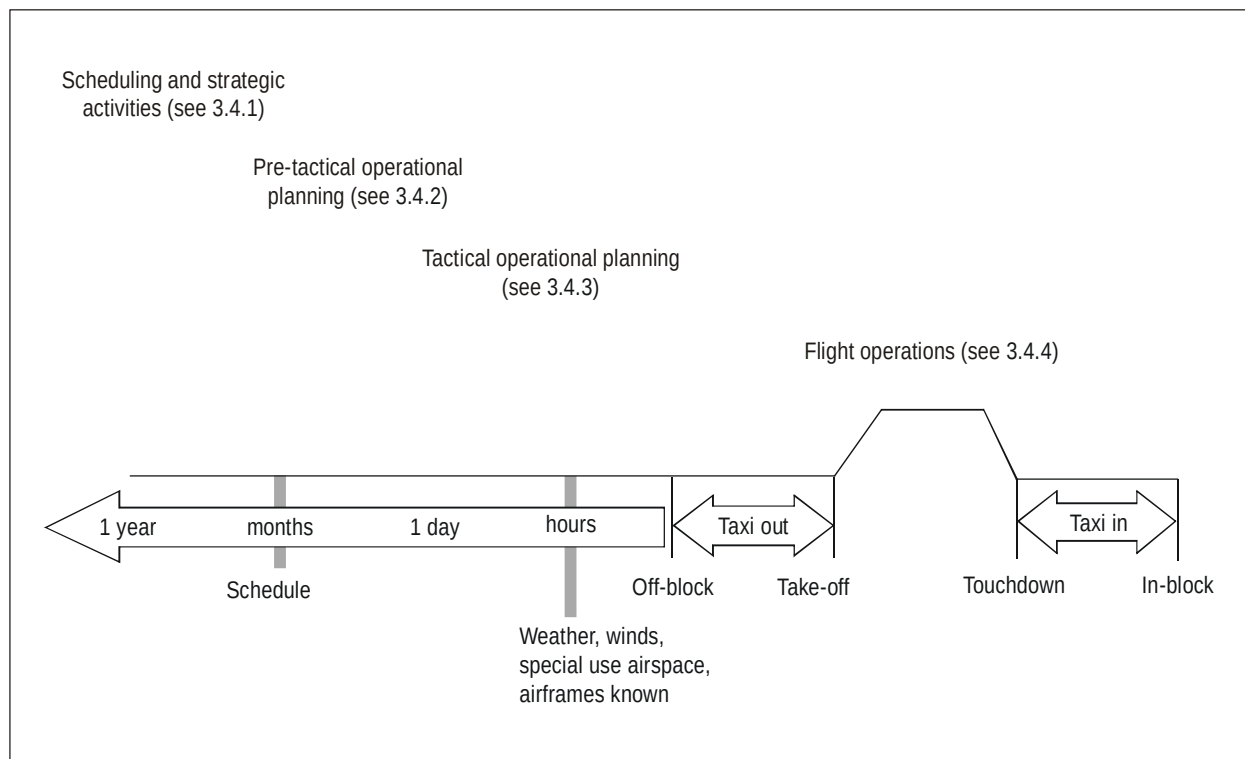


Figure 3-6. Timeline of information provision relative to events pertaining to a single flight, referenced sections detail FF-ICE activities in more detail

3.6.4 Initial information provision may occur at any point along the timeline. For example, differing airspace users may have different planning horizons as described in 3.11. This initial information will be provided through a designated point-of-entry (POE, see Appendix F, 6) and to an ASP typically applicable to the flight's departure point. Some ASPs may accommodate multiple POEs, and some ASPs may accommodate the receipt of initial flight information from POEs not explicitly associated with a flight's departure point. Clarity regarding responsibility for information is aided by information audit trails.

3.6.5 This ongoing flight information process can also be described in terms of a timeline of related and interacting activities being performed by the various participants (see Figure 3-7). The timeline employs language from the *Global ATM Operational Concept* and illustrates the times at which concept components are employed to deliver a single flight.

3.6.6 The figures describe the timeline for a scheduled flight operating through multiple ASPs with the following important points:

- the various ASPs encountered will be conducting activities to deliver various concept components at different points in time. For example, tactical DCB activities will not necessarily occur at the same time for the departure and arrival ASP;
- while it is recognized that many of the concept components will be executed through collaboration between multiple participants, Figure 3-7 illustrates the dominant participants in each component;

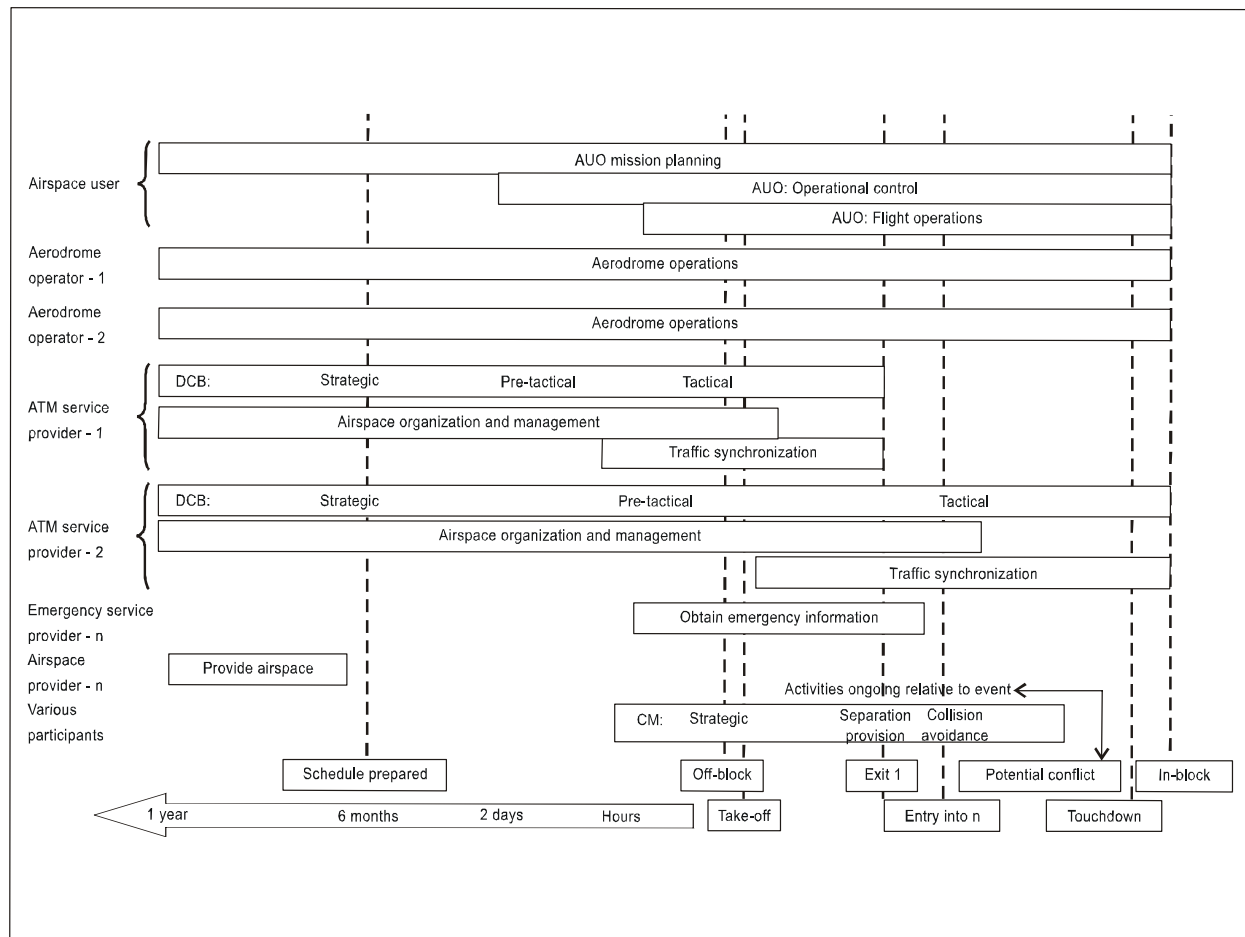


Figure 3-7. Timeline of activities focussed on concept components

- c) collaboration on each component will occur through the sharing of information among participants;
- d) requirements will be levied on participants to supply specific information by certain deadlines in relation to events; and
- e) the FF-ICE will be updated dynamically throughout the operation of a flight.

3.6.7 follows:

The timeline for flight information will be governed by the availability and quality of information. A summary

- a) planning activities for a flight begin before a schedule is developed. Collaboration on demand levels, airspace permissions, and planned aerodrome and airspace capacity levels allow decisions to be made on an initial flight schedule;
- b) knowledge of scheduled operations allows additional capacity management and airspace organization. Initial schedules can then be modified;
- c) as operational constraints (e.g. meteorological conditions, winds) become known, more detailed information on a flight can be provided including the flight route and information required for SAR;

- d) after departure, flight information can be updated continually as a result of changing conditions or operational impacts; and
- e) post arrival information can be archived to support performance reporting necessary for a performance-based ATM system as envisaged in the *Global ATM Operational Concept* and Doc 9883.

3.6.8 The timeline for an example flight is described below in greater detail in terms of the activities shown in Figure 3-6. The effect of the user types on the timeline is described in 3.11.

3.7 SCHEDULING AND STRATEGIC ACTIVITIES

3.7.1 Providing long-term intent, when available, aligns with the *Global ATM Operational Concept* which calls for users to supply long-term intent information for the purposes of identifying imbalances. Advanced intent information can also be used for airport operations, military operations, and diplomatic clearances. This can occur as far as one year before departure, at which point not all flight planning information needs to be provided. As a flight approaches and confidence is gained in the information, additional fields may be populated.

3.7.2 As a result of AUO mission planning, airspace users with a longer planning horizon supply the type of information commonly found in schedules today (e.g. origin, destination, aircraft type and estimated times of arrival/departure). The information from many flights is used as part of strategic DCB to collaboratively determine acceptable schedules to deliver a performance level (including capacity) consistent with the anticipated demand. Provided information will be used for AOM, planning activities for AO and providing airspace permissions.

3.7.3 ASPs will determine their demand by using a combination of historical information, expected growth patterns, information from special events (e.g. large sporting or cultural events causing changes in traffic patterns), and early FF-ICE information. This early information will thus be used to refine the other information but is not expected to replace it as the sole source of “demand” information.

3.7.4 Airspace user-provided information is subject to change as the information becomes known with greater certainty closer to departure. Operators providing this information are expected to update it as more accurate planning information becomes available. Flight information will be updated by referencing a global common identifier for a flight.

3.7.5 Airspace users may wish to provide information for flights which will operate in the same manner on a repeated basis. This is acceptable provided that all required information is provided and correct. However, in certain environments, system performance considerations may require a greater level of interaction and customization of flight information.

3.7.6 Nothing precludes an operator from supplying more information at an earlier point in the timeline. ASPs should consider the impact that methods which alter the time at which users are motivated to file have on ATM system performance.

3.8 PRE-TACTICAL OPERATIONAL PLANNING

3.8.1 At some point before departure, demand and traffic flow patterns begin to crystallize. At this time, a plan can be developed taking into account the information that is known. However, the specific operational conditions (e.g. meteorological conditions, winds, system outages, maintenance issues) are not known precisely. Developing this plan is the role of the pre-tactical stage of DCB envisaged in the *Global ATM Operational Concept*. The pre-tactical DCB provides a plan to be followed if no tactical disturbances are encountered. As described in the *Global Air Traffic Management Operational Concept* (Doc 9854):

“At the pre-tactical stage, demand and capacity balancing will evaluate the current allocation of ATM Service Provider (ASP), airspace user and aerodrome operator assets and resources against the projected demands. Through collaborative decision-making (CDM), when possible, adjustments will be made to assets, resource allocations, projected trajectories, airspace organization, and allocation of entry/exit times for aerodromes and airspace volumes to mitigate any imbalance.”

3.8.2 Collaboration occurs among AUO, AO, DCB, and AOM, resulting in refinement of the FF-ICE information previously provided. Other types of information (e.g. aeronautical information and access requirements) may also be changing.

3.9 TACTICAL OPERATIONAL PLANNING

3.9.1 Closer to the flight operation time, the ATM system has access to more accurate planning information such as meteorological conditions, specific airframe availability, winds, resource demand, equipment outages, and requirements on military operations areas. AOs can provide airport capacity and configuration forecasts. AOM can respond to these updated conditions (e.g. convective weather, military activity).

3.9.2 As a result of this improved source information, AUOs refine previously provided information and provide new information previously not known. Examples include:

- a) improved forecasting of departure times as the status of inbound aircraft become known;
- b) better estimated times en route as wind information is known;
- c) precise knowledge of airframe to be used and flight capability;
- d) explicit knowledge of the desired route of flight to incorporate winds and avoid segregated airspace and convective weather areas; and
- e) knowledge of information necessary to generate desired 4D trajectories.

3.9.3 The accuracy of information will continue to increase as the forecast horizon decreases. The impact of the improved information will be evaluated by participants, and information will be updated as appropriate. Updates will continue throughout the flight operation.

3.9.4 The tactical planning phase of DCB continues to collaboratively adjust the 4D trajectory to ensure system resources are not overloaded. As part of the collaborative SWIM environment, participants will have access to consistent and continuously updated information regarding expected constraints in the system. Timely access to such information will enable both operators and service providers to take action (e.g. request a re-route or be offered access to another route) as new information becomes available. This collaborative process is expected to optimize 4D trajectories. Information contained within the FF-ICE will support the collaboration and performance objectives.

3.9.5 Information supporting ESPs (e.g. SAR information) is available at this time. Strategic CM and TS may begin before departure, resulting in the imposition of constraints and tolerances on the 4D trajectory.

3.9.6 Some of the tactical operational planning activities continue as the flight operates, such as replanning to accommodate dynamic constraints. However, a certain amount of information will be required before flight operation. Local performance requirements may require that the information be stable for some time period before departure or entry into a region.

3.10 FLIGHT OPERATIONS

3.10.1 Once the flight has begun operation, FF-ICE information continues to be shared among the relevant participants of the ATM community. Information contained in the FF-ICE forms the basis of the agreed 4D trajectory, upon which tactical decisions are made. For this reason, it is necessary that this information be current. This is accomplished through updates to the FF-ICE and may occur for a variety of reasons as follows:

Tactical control — For certain ASPs, tactical controllers may take actions on the flight, leading to changes in the FF-ICE in support of CM or TS. This may include assigning altitudes or speeds or local changes to routing. These can impact the downstream agreed upon 4D trajectory and must be updated to allow downstream “pre-tactical” DCB planning to occur.

Collaborative tactical operational planning — Example

In the hours preceding any predictive convective activity, the ASP identifies that severe meteorological conditions forecasts indicate a portion of the airspace may experience capacity constraints due to convective activity. The ASP defines the airspace to be monitored and shares this information with airspace users. In response, airspace users pre-emptively develop plans for flights that are potentially affected by the airspace being monitored. These plans take the form of a set of ranked trajectories with a tolerance on delay for each flight. A minimum notification time may be provided for some trajectories requiring additional time (e.g. to add additional fuel).

As time progresses, meteorological conditions forecasts become more accurate and begins to materialize as predicted. Through common situational awareness, the airspace users and the ASP collaboratively determine the need to constrain the airspace and set a capacity. Using the set of ranked trajectories with tolerances, automation indicates that the capacity cannot accommodate all highest-priority trajectories. In accordance with a set of pre-collaborated rules balancing across key performance areas, demand is adjusted to capacity using the trajectory rankings and tolerances. Some flights are delayed within their tolerances; others are re-routed taking into account the user-provided priority.

Later in the day, capacity may have to be adjusted up or down. The described collaborative process is repeated as necessary to ensure capacity is not exceeded. As meteorological conditions begin to improve over the forecast, the ASP and airspace users will collaboratively determine a new, increased capacity forecast. This will allow some previously delayed and re-routed flights to use their most preferred option. As before, this assignment is accomplished by considering pre-collaborated rules. For departed flights, their most preferred option will depend on their present location.

Changing constraints — Constraints may appear or relax compared to an earlier forecast (e.g. meteorological conditions deteriorate or improve, a military training area becomes available or not, etc.). Through a collaborative process, the flight and associated FF-ICE can be altered to accommodate the new constraints. The collaboration process may be triggered by either the service provider or the operator and may be real time interactive (either an iterative exchange between fully automated systems or with human participation) or based on operator preferences, which may be defined by conditional rules or priority, and may vary for each individual flight.

Dynamic demand — As operations proceed and forecasts change, forecast demand may change, leading to lower or higher than expected demand. Again, a collaborative process seeks to accommodate the constraints subject to meeting the operators’ preferences in an equitable manner.

Known information — Certain information will only become known with certainty at later points in time. For example, this may include the arrival runway information and the arrival route in the terminal area. This information will be updated as the information becomes available.

Transfer of control — Flights may progress through various regions with differing performance and service levels (see 4.6.10).

3.10.2 While increased collaboration is expected, it is recognized that the need for immediate tactical decisions will result in collaboration being curtailed at some point in accordance with known rules of conduct. These rules will have been pre-established using a collaborative process.

3.11 EFFECT OF USER TYPE ON TIMELINE

3.11.1 While information provision is expected to be event-generated, it is recognized that there are a variety of categories of airspace users, and they may be responding to internal events consistent with their own business or mission objectives. As an example, consider the main events during the planning and execution of a flight viewed from the perspective of three types of airspace users (there may be other airspace users not identified here, e.g. air-filers):

Airspace user who is a seasonal planner — This is the type of airspace user who decides to fly more than a month before the flight will take place; for example, an airline. Useful early information about the flight intentions could be obtained from this type of airspace user well in advance of the date of flight and be used by ASPs to refine their traffic forecasts, strategic plans, controller rosters, etc. When using a coordinated airport, this type of airspace user may have to wait until the airport slots are available before providing certain information items.

Airspace user who is a medium-term planner — This is the type of airspace user who decides to fly between one day to one month before the flight will take place; for example, a charter operator or certain military airspace users. Information cannot be provided by this type of airspace user as early as seasonal planners, but some useful information should be available before the day of flight.

On-demand airspace user — This is the type of airspace user who decides to fly within 24 hours of the flight; for example, a business jet, air taxi, or certain types of military airspace users. Early information cannot be provided by such AUs because they simply do not know when or where they will fly until the day of flight. Thus, their initial submission will have to contain significantly more information.

3.11.2 The flight information provided by all types of airspace users is expected to evolve by means of an iterative process throughout the period from initial submission until termination of the flight. Table 3-1 illustrates, through an example, the timeline of events and type of information provided by the different types of airspace users.

3.12 SCHEDULED FLIGHT SCENARIO

3.12.1 This section presents a high-level scenario describing the evolution of the information for a scheduled flight. The high-level scenario is broken into smaller scenarios, described in more detail in Appendix C. These smaller scenarios are described through interaction between the participants identified in 3.3. The overall relationship between these scenarios is illustrated in Figure 3-8. The activities are loosely organized in time, but there is no specific time order to many of the activities described. For example, while initial information provision must occur first, and some activities must occur before or after departure, many other activities may occur in any order.

3.12.2 For clarity, Appendix C defines interactions mostly with a single ASP. It is recognized that multiple ASPs may be involved throughout the flight's life cycle. It is assumed that the functions performed by a single ASP will also be conducted across multiple ASPs by sharing information pertinent to applicable portions of a flight's 4D trajectory.

➤ An example is provided in Appendix C, Figure C-7, *Negotiation Across Multiple ASPs*.



Table 3-1. Example of events for different airspace user types

<i>Event timeframe</i>	<i>External event</i>	<i>Seasonal planner airspace user (decides to fly > 1 month before flight)</i>	<i>Medium-term planner airspace user (decides to fly 1 day to 1 month before flight)</i>	<i>On-demand airspace user (decides to fly within 24 hours of the flight)</i>
3-9 months before estimated departure block time and date	Airport slot determined at coordinated airport	Airline schedule published containing at least: departure, destination, estimated departure block time and date, estimated arrival block time and date ¹		
More than one month before the estimated departure block time and date	Strategic traffic forecast	Provides: • aircraft operator information • flight identification • departure and destination aerodromes • type of aircraft • estimated departure block time and date • estimated arrival block time and date • desired 4D trajectory² • airport slot (only for coordinated airports, and only after slot conference)		
One month to one day before the estimated departure block time and date	• pre-tactical traffic forecast • special events known • military demand known for major exercises • aeronautical information	Provides: • revisions in response to changing constraints • access provisions	Provides: • aircraft operator information • flight identification • departure and destination aerodromes • type of aircraft • estimated departure block time and date • estimated arrival block time and date • desired 4D trajectory • airport slot (only for coordinated airports, and only after slot conference) • access provisions	

1. Used by ASPs/airports for validation of demand forecasts.
2. It is recognized that more than 1 day prior to departure, not all flights will have a stable, preferred 4D trajectory (e.g. when winds are an important factor). Unequipped aircraft may provide a minimum trajectory consistent with ATM system performance requirements.

<i>Event timeframe</i>	<i>External event</i>	<i>Seasonal planner airspace user (decides to fly > 1 month before flight)</i>	<i>Medium-term planner airspace user (decides to fly 1 day to 1 month before flight)</i>	<i>On-demand airspace user (decides to fly within 24 hours of the flight)</i>
One day to 30 minutes before the estimated departure block time and date	• meteorological conditions updated • tactical traffic forecast • negotiating 4D trajectory • passengers and cargo known • military demand known • forecast of departure configuration known • aeronautical information	Provides: • overall performance • alternate aerodromes • updates to desired 4D trajectory and negotiation to determine an agreed 4D trajectory	Provides: • overall performance • alternate aerodromes • updates to desired 4D trajectory and negotiation to determine an agreed 4D trajectory	Provides: • aircraft operator information • flight identification • departure and destination aerodromes • type of aircraft • estimated departure block time and date • estimated arrival block time and date • desired 4D trajectory • airport slot (only for coordinated airports, and only after slot conference) • access provisions • overall performance
30 minutes to estimated departure block time and date	• fuel load determined • current meteorological conditions available • agreed 4D trajectory available	Provides: • overall performance (impacted by weight) • agreed 4D trajectory, including updated estimated take-off times and taxi path (if applicable) • SAR information	Provides: • overall performance (impacted by weight) • agreed 4D trajectory, including updated estimated take-off times and taxi path (if applicable) • SAR information	Provides: • overall performance (impacted by weight) • agreed 4D trajectory, including updated estimated take-off times and taxi path (if applicable) • SAR information
Off-block	Start-up clearance	Actual departure off-block time and date	Actual departure off-block time and date	Actual departure off-block time and date
Take-off		• take-off runway time in executed 4D trajectory • updates to agreed 4D trajectory		