Globally Unique Flight Identifier (GUFI) Requirements

The Flight Information Exchange Model (FIXM) contains the data element GUFI. The purpose of the GUFI is to have an identifier that allows any Air Traffic Management (ATM) flight data to be easily and accurately correlated with any other ATM flight data. Using the GUFI, all systems can be sure they are referring to the same flight when exchanging data about that flight. This paper presents background information on general issues regarding unique flight identification, such as defining "what is a flight", and proposes a set of GUFI requirements that can serve as input to the collaborative process defining an internationally accepted GUFI.

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Document History

Version	Version Type	Description of Changes
1.0		Document originally released as ATMRPP-WG23-WP/549 for the International Civil Aviation Organization (ICAO) Air Traffic Management Requirements and Performance Panel (ATMRPP) 23rd Working Group Meeting in Brussels on March 4 to 8, 2013.
2A	DRAFT	Modified to differentiate between schedule data and operational flight data and to clarify the role of the GUFI in this context.
2B	DRAFT	Modified to reflect comments from the International GUFI TIM held on 3/26/14.
2C	DRAFT	Modified to reflect comments from the International GUFI TIM held on 5/5/14. A significant change is that all discussion of implementation and experiments previously performed have been separated out into another document. Other changes of note are: 1. The context was clarified to distinguish schedule data from commercial data that is exchange about individual flights using AIDX. 2. A requirement was added to support interoperability with commercial flight data. 3. A requirement was added to limit use of the GUFI to flight identification. 4. A requirement was moved from the format paper: this ensures that the GUFI is usable by all stakeholders. 5. Requirements were added to the transition section to clarify how the end-state requirements apply in the transition environment.
2D	DRAFT	Several minor clarifications from GUFI TIM held on 5/14/14.
2E	DRAFT	A few editorial corrections.
2.0	Final	2E with several minor edits. Ready for distribution.
2.1	Final	2.0 with several small editorial corrections.

Introduction

The development of the Flight Information Exchange Model (FIXM) (reference 10) is an ongoing collaborative effort among international flight data stakeholders. A key data element of the FIXM model is a Globally Unique Flight Identifier (GUFI). The Federal Aviation Administration (FAA) has been analysing the need for the GUFI, the role the GUFI should play, and the requirements for the GUFI for the last several years (references 1, 2, and 3). That work benefited from discussions with Airservices Australia and the Japan Civil Aviation Bureau (JCAB). Complementary work analysing the GUFI has also been carried out by Eurocontrol (reference 4). The resulting concept has been reviewed and revised by a set of FIXM international stakeholders. The purpose of this paper is to present the current consensus definition of the concept and requirements for the GUFI.

1 Background/Discussion

1.1 Purpose

The purpose of the GUFI is to provide an identifier that can be used to unambiguously associate any operational Air Traffic Management (ATM) flight data transaction with other ATM data related to a particular flight.

> Note: The term ATM data is introduced here to describe data transactions, such as flight plans, that a flight operator exchanges with an ATM system, and that ATM systems exchange with each other. This is to differentiate the data described here from schedule and other types of flight data. ATM flight data exchange starts the first time a flight operator exchanges planned data about an individual flight with an ATM system, and ends when the flight has reached the arrival gate. The GUFI could have broader application as well, but the requirements are written from an ATM perspective.

The goal is to help ensure that all systems (both flight operator and ATM) maintaining ATM data for a flight apply the data transactions to the correct flights. Consider a simple example:

- An airline notifies a Traffic Flow Management (TFM) system of a planned flight from airport A to airport B.

- The airline files a flight plan with an Air Traffic Control (ATC) system for this same flight.

- A constraint exists at airport B causing the TFM system to change the departure time for the flight.

- The TFM system sends a new departure time to the airline and to the ATC system.

It is critical that the airline and ATC system each apply the revised departure time to the same flight. But the data that the airline files on the ATC flight plan might not exactly match the data previously sent to the TFM system, making this correlation uncertain. (As an example, an airline might file the flight plan with a slightly different Flight Identification than was used when data was submitted to the TFM system to avoid a similar call sign.) If the airline, TFM system, and ATC system all use the same identifier – the GUFI – for the flight, it makes it easy for the TFM system to unambiguously identify the affected flight to those other systems. This example also illustrates that the GUFI is important not only to the Air Navigation Service Providers (ANSPs), but to all stakeholders that have any involvement in the operation of a flight.

While this is a very simple example, one can easily imagine that as more stakeholders are involved, there are more opportunities for mismatched data leading to a loss of data integrity, which can impact operational efficiency. For air traffic operations to work efficiently and accurately, it is critical for every stakeholder – flight operator, ANSP, airport operator, fuel service, catering service, etc. – to have the exact same picture of what flights are operating and what the exact plans are for those flights.

The need for a GUFI has long been recognized in the international community. Unique flight identification has been cited as a key to the development of the Global Air Traffic Management (ATM) system. According to the Global Air Traffic Management Operational Concept: "the future [global] ATM system … will rely on explicit and unambiguous information and on wide information exchange within the system" (reference 5, p. 2-15). The Flight and Flow Information for a Collaborative Environment (FF-ICE) concept document carries this further to identify the GUFI as an integral component towards achieving this goal and solving the problem of "Inconsistent Flight Information" (reference 6, section 2.4.2). The International Civil Aviation Organization (ICAO) System Wide Information Management (SWIM) concept highlights the importance of the GUFI for flight information interoperability (reference 7, section 3.1).

1.2   Context

There are two contexts in which the issue of flight identification resides: commercial data and ATM data.

Commercial data starts with schedules used to plan sequences of flights far into the future, typically up to a year. Schedule data describes the intent to operate flights between an airport pair at given times, on given days of the week, over a given range of dates. Schedules are generally defined using International Air Transport Association (IATA) codes and flight numbers, and may include planned aircraft type and route. Schedule data is used for purposes such as reservations, ticketing, and airport planning (including airport slot reservations). The Standard Schedules Information Manual (SSIM) (reference 8) is the defined standard for exchanging bulk schedule data.

Commercial data is also exchanged for individual flight occurrences. An example of this is a data exchange between an airline and an airport operator to provide up-to-the minute times and status for scheduled flights on a given day. The airport operator uses this information to update the airport flight information displays, among other uses. The Aviation Information Data Exchange (AIDX) standard (reference 9) has been defined for exchanging commercial data for individual flights. An important component of AIDX is the Unique Flight Identifier (UFI). An important characteristic of the UFI is that its components can be used to associate a commercial flight instance with the commercial schedule from which it is derived.

ATM flight data is used to coordinate the operation of a particular flight between the flight operators and the ATM service providers. ATM data typically includes the call sign (to be used for radio communications with the flight), aircraft type and equipage, registration number, route, cruising speeds and altitudes, and safety and rescue information; that is, all the data in the ICAO flight plan. ATM flight data is expressed using ICAO codes and is used to perform operational ATM functions such as separation, hand-off between ATC facilities, search and rescue, and the exchange of flight information between aircraft operators and ANSPs. FIXM is the standard being developed for exchange of ATM data, and the GUFI is the element of FIXM that distinguishes the flight.

Commercial and ATM data exchanges will be performed according to their own separate standards using their own flight identifiers. However, there is a clear relationship between the two types of data. That is, it will be important for some systems to know which flight, defined using commercial data, matches a flight defined using ATM data. Consider a case where an airport arrival slot has been

allocated to a scheduled flight. The airport operator uses the commercial flight data to associate the flight with its slot. However, the airport operator may also receive flight plan and track data for the flight in ATM format. The airport operator must be able to correlate the ATM flight with the commercial flight and airport slot. Making this more difficult is that the Flight Identification on the flight plan might not include the same airline code as the commercial data.

To make this association possible, when an ATM flight is created for a commercial flight, not only should a GUFI be assigned to the ATM flight, but also the commercial flight identifier (the AIDX UFI) should be saved as a data attribute for the ATM flight. This makes it possible to associate the flight plan or other ATM flight data with an airport arrival slot or with other commercial data.

1.3   Defining a Flight

To define a unique flight identifier, it is necessary to first define a unique flight. There are several issues related to this definition.

First is the distinction between a flight leg and an itinerary. A flight operator might be planning to operate a flight from airport A to B to C using one aircraft identifier. The operator might consider this to be one flight. However, from an operations standpoint, these are two distinct operations. Each leg of this flight has its own flight plan, departure time, route, etc. For an airline, each flight leg might possibly be operated using a different aircraft. Each leg has to be separately planned and fuelled. Each leg has a distinct and separate impact on airport and airspace capacity. For this reason, a flight is defined here as a single flight leg. (This argument ignores the case of formation flights, in which multiple aircraft may operate on a single flight plan. The use of the GUFI for this case is yet to be determined.)

Second is the definition of a *unique* flight. Consider the following case. An airline might plan to operate a flight from airport A to airport B. The flight departs from airport A, encounters bad weather on its way to airport B, and then returns to airport A. Later, when the weather improves, the flight again departs from airport A and lands at airport B. Is this one flight or two flights? From the perspective of a passenger trying to fly from airport A to airport B, this might seem like one flight. However, from an operations perspective there are two movements. The flight used two departure slots at airport A, and two arrival slots – one at A and one at B. The flight was fuelled twice. The second attempt has a different flight plan and might even use a different aircraft. For this reason, a flight is considered here to be a single operation that departs once and lands once. (Note: Each of these flights would have a different GUFI. If this is a commercial flight, each would also have a different AIDX-UFI, but could be linked to the same scheduled flight using the AIDX-UFI.)

In summary, for the purpose of discussing the GUFI, a flight is defined as a single operation of an aircraft from takeoff to touchdown. By this definition, a "ground return" – that is, an aircraft pushing back from the gate and then returning to the gate without taking off is not considered a flight.

> Note: This definition is consistent with the AIDX definition of an individual flight except in the case of a ground return. AIDX considers a ground return to be a flight; that is, the resumption of that intended flight is a separate flight with its own identifier. For ATM purposes, a ground return is not considered to be a separate flight, but just a delay to the originally planned flight. An ATM system would show such a flight as changing status from "at-the-gate" to "off-the-gate" back to "at-the-gate".)

A more detailed discussion of the difficulties in identifying unique flights can be found in reference 1.

1.4   Natural Identifiers and Past Problems

Many systems have exchanged ATM data in the past using different approaches to flight identification; unfortunately, none of these has yet provided a satisfactory solution. Just within a single ANSP's systems, there are many lessons to be learned. Some of these approaches, along with their shortcomings, follow:

- Aircraft Identification (a.k.a., Call Sign) – Shortcomings: the Aircraft Identification for a flight can change; the same Aircraft Identification can be used for more than one flight leg.

- Registration Number (a.k.a., Tail Number) – Shortcomings: an airline can substitute an aircraft, thus changing the registration number, but still using the same aircraft identification, same flight plan, and flying the same planned operation.

- Aircraft Identification in combination with Origin and Destination – Shortcomings: again, the Flight Identification can change; the destination can change; the same Aircraft Identification can be used to operate from the same origin to the same destination more than once in a day.

- Aircraft Identification, Origin, Destination and Departure Time – Shortcomings: in addition to the above, departure times can change.

The main point being made here is that these past attempts have been made using "natural identifiers"; that is, identifiers created from data attributes that already exist for a flight. These approaches are problematic, primarily because the values of the attributes can change. If an incoming transaction has different values for any of the identifying attributes, there is no way to match that data with certainty. And once data is distributed across many systems, it is then hard to ensure that changing values can be kept synchronized across all systems. (Note: This does not mean that a GUFI cannot be originally generated from natural data; however, once a GUFI is constructed, it can never change, even if the related data attributes change.)

It should be stressed that these problems have occurred with ATM data exchange and cannot be extrapolated to other environments. The AIDX-UFI, for example, is a natural identifier that is used successfully for commercial flight data exchange.

A more detailed discussion of past problems with ATM flight data matching can be found in reference 1.

1.5   Unique Flights or Flight Plans

In some ATC environments, including the FAA's National Airspace System, it is possible for a flight operator to file more than one flight plan for a single flight. This concept is not supported by FIXM or by the GUFI. Under FIXM, there can only ever be one set of data associated with a flight, and that data must have a single GUFI associated with it; that is, there is a one GUFI, one flight relationship.

This is not to say that a flight data set can't include alternative values within that data set. For example, an ICAO flight plan includes a planned destination as well as alternate destinations, and AIDX allows saving the original destination as well as the current destination. A flight data set could be allowed to have alternative route options, as another example, but is not likely to allow multiple aircraft types. FIXM use cases will determine which fields can have multiple values and which cannot. From the perspective of defining the GUFI, the important point is that there is only one set of data for a flight, and one GUFI associated with that data set.

1.6   When Should a Flight Be Instantiated?

If a clear distinction is made between schedule data and individual flight data, as described in Section 1.2, a question arises: What event should trigger an airline to create an individual flight instance from a flight schedule? And should this trigger be the same for commercial data and ATM data? From the perspective of the GUFI, it doesn't matter; that is, defining these triggers it outside the scope of defining requirements for the GUFI. The important point for the GUFI is that whenever an ATM flight is instantiated, a GUFI be assigned to it. When this happens should be determined by other system requirements. For example, if an ATM system needs intent data from flight operators 24-hours prior to departure, scheduled flight operators should instantiate flights at least 24-hours prior to departure. What is important is that the GUFI be established before safety-critical data exchanges occur.

Note: An important benefit of this approach is that there is no need for a scheduled operator to create or assign GUFIs for scheduled flights ahead of time. For example, if a flight is scheduled to operate every day for the next year, the flight operator does not need to create, store, and maintain 365 GUFIs for this flight.

1.7   General Concept of Use

In order to achieve the goals presented above, the GUFI should be used as follows:

- The first time any ATM data is shared between any two systems for a flight, a GUFI must be assigned to the flight. (Note: The "sharing" of data might be through a data publication or a web service, such as a service for creating a flight plan.)

  o The flight definition should also include the commercial flight identifier (the AIDX UFI), to allow interoperability between the ATM and commercial data.

- Any system that subsequently provides ATM data for that flight must include the GUFI as part of every data transaction.

- Any system that processes ATM data for a flight must use the GUFI to associate the data in the transaction with its internal representation of the flight's data.

Consider the simple example from Section 1.1. A GUFI could be applied as follows:

- The airline creates a GUFI for a flight before it first sends any flight data to any ATM system.

- The airline creates the flight in TFM, including the GUFI.

- The airline files the flight plan with ATC, including the GUFI.

- TFM sends a control time update to ATC and the airline, including the GUFI in both transactions.

Every system stores the GUFI and every transaction contains the GUFI. Apart from a "create" transaction, every system uses the GUFI on an incoming transaction to match the data to the flight in its database. There can be no ambiguity as to which flight any data transaction belongs. (Note: It is also possible in this example that the TFM system could have generated the initial GUFI and sent it back to the airline as part of the two-way flight creation transaction. The example presented above shows just one possible approach.)

2 Requirements

Following are requirements for the GUFI. The formal statement of each requirement is shown in **bold text**. Additional, non-bolded text is included to help explain and clarify the requirement.

Note: All these requirements apply to the operational ATM context as described in Section 1.2. These requirements do not apply to schedule data.

2.1   End-state Requirements

The first set of requirements describes how the GUFI works in the idealized end-state environment, where all systems include a GUFI on every ATM flight data transaction. These requirements apply only to ATM systems and data exchanges, as discussed in Section 1.2.

The first requirement derives from the purpose of the GUFI: to exchange data reliably between systems.

1) **Every ATM flight data transaction for a flight, between any stakeholders, shall include the GUFI.**

   For example, the flight operator, airport operator, and others are part of the GUFI processing, not just the ANSPs.

The next five requirements specify the qualities of the GUFI used on the ATM flight data transactions.

2) **Every unique flight shall have a GUFI.**

   A unique flight is defined as a single operation of an aircraft with one takeoff and one landing.

3) **Only one GUFI shall ever be assigned to a flight.**

   For example, two different ANSPs cannot each assign their own GUFI to the same flight. And once a GUFI is assigned, it cannot be changed.

4) **A given GUFI shall only be assigned to one flight within a ten-year period.**

   This, along with the previous requirement, assures that there is a one GUFI – one flight relationship. A ten-year period was chosen as a reasonable, minimal requirement. This does not preclude the implementation of a GUFI that is unique for a longer period, or forever.

5) **The GUFI shall accommodate any flight of interest to any stakeholder.**

   For example, the GUFI shall not be designed to preclude its use for military or general aviation (GA) flights.

6) **The GUFI definition shall be based on accepted global standards.**

   At all times we endeavour to adopt global standards.

7) **A GUFI shall be used for flight identification only.**

   The GUFI content shall never be used within any business rules. In particular a system can take no business decision based on the GUFI content. This applies only if the GUFI includes recognizable flight data elements.

2.2   Interoperability Requirements

The second group of requirements are not strictly GUFI requirements, but are requirements related to flight identification. As discussed in Section 1.2, there are types of flight data other the ATM data; two examples are commercial schedule data and AIDX-based commercial flight data transactions. The purpose of these requirements is to ensure that the FIXM, GUFI-based data exchange will allow flight operators and other systems to easily and accurately correlating GUFI-based, ATM data transactions with other types of data.

8) **FIXM shall include fields for expressing other approved, standardized flight identifiers.**
Practically speaking, this means the AIDX-UFI. The components of the AIDX-UFI can be used to correlate FIXM-based data with schedule data as well as the AIDX-based commercial data. Note that the AIDX-UFI is composed of multiple, smaller data items.

2.3   Transition Requirements

The idealized end-state environment, assumed in Section 2.1, is not likely to exist for a long time, if ever. That is, some flight operators and/or ANSPs may continue to operate legacy systems that have not converted to the FIXM data formats and GUFI usage. It is important, therefore, to define requirements that specify how the GUFI works in a mixed environment, where some systems have implemented the GUFI and some have not. In these requirements, the term "GUFI-enabled" is used to mean systems that have implemented the GUFI, or transactions that contain the GUFI. The term "legacy" is used to refer to systems that have not adopted the GUFI, and transactions that do not contain the GUFI.

These requirements apply to both ANSP and flight operator systems.

First, it is necessary to clarify how the previous requirements from Sections 2.1 and 2.2 apply in the transition environment.

9) **Requirement 1), defined above, shall be modified in the transition environment as follows: Every GUFI-enabled ATM flight data transaction for a flight, between any stakeholders, shall include the GUFI.**

10) **Requirement 2), defined above, shall be modified in the transition environment as follows: Every unique flight for which data is exchanged with a GUFI-enabled flight data system shall have a GUFI.**

That is, if a flight only operates within the domain of legacy systems, we do not expect it to get a GUFI.

11) **Requirements 3) through 8), defined in Sections 2.1 and 2.2, shall apply in the transition environment.**

The following new requirements state how GUFI-enabled systems must work in the transition environment.

12) **A GUFI-enabled flight data system shall continue to support legacy interfaces with legacy flight data systems after it has implemented the use of the GUFI.**

13) **A GUFI-enabled flight data system shall assign a GUFI to a flight that is created from a legacy source and include that GUFI in transactions to GUFI-enabled systems.**

The system that is assigning the GUFI must determine whether a GUFI has already been created for the flight by any system; if so, the existing GUFI must be used. If no GUFI has yet been created for the flight, the system creates and assigns a new GUFI.

14) **A GUFI-enabled flight data processing system shall merge legacy and GUFI-enabled data, and provide the merged data in transactions to both legacy and GUFI-enabled systems.**

3   Implementation and Transition

While it is premature to plan how the GUFI will be implemented, there are some significant issues that one should be mindful of when considering the requirements for the GUFI. Several of these issues are presented here. These issues will be addressed during the design process and documented separately.

- Who is responsible for creating GUFIs? Does the flight operator assign a GUFI before sending any data to an ATM system? Does the ANSP generate the GUFI when a flight is first created?

- How are GUFIs kept unique? From an abstract perspective, if there were one source of GUFIs (for example, a global GUFI service), it would be easy to ensure that they were unique and consistent. However, from a practical standpoint, it is hard to imagine a single, global GUFI generator. A more practical approach would be to have national or regional GUFI generators, coordinating with each other to ensure uniqueness. Or could each system, including flight operators, generate GUFIs but still guarantee uniqueness?

- When does flight data change so much that a new GUFI is needed? For example, if a flight changes its destination, it is still recognizable as the same flight. If both the origin and destination change, this should be considered a new flight.

- What does a transition environment look like? It is reasonably straightforward to see how the GUFI is exchanged and used when all systems include GUFIs on all transactions. However, there will be a time – perhaps a long time – when some systems are using the GUFI and some are not. How does an ATM system communicate with both GUFI-enabled and legacy flight operators? How does a flight operator process data updates from both GUFI enabled and legacy ATM systems? How is a GUFI maintained as a flight transitions from a GUFI-enabled ATM system to a legacy ATM system to another GUFI-enabled ATM system?

- How to make sure only one GUFI is assigned to a flight? There are many different data exchanges between different systems. If for example, a flight is flying from Spain to Canada, a flight operator might submit data independently to both the Spain and Canada ATM systems. How do these systems know whether the other has allocated a GUFI?

Appendix A   Acronym List

Acronym	Definition
AIDX	Aviation Information Data Exchange
ANSP	Air Navigation Service Provider
ATC	Air Traffic Control
ATM	Air Traffic Management
ATMRPP	Air Traffic Management Requirements and Performance Panel
FAA	Federal Aviation Administration
FF-ICE	Flight and Flow Information for a Collaborative Environment
FIXM	Flight Information Exchange Model
GA	General Aviation
GUFI	Globally Unique Flight Identifier
IATA	International Air Transport Association
ICAO	International Civil Aviation Organization
JCAB	Japan Civil Aviation Bureau
SWIM	System Wide Information Management
SSIM	Standard Schedules Information Manual
TFM	Traffic Flow Management
UFI	Unique Flight Identifier

Appendix B   References

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