FLIGHTAWARE WHITE PAPER | AUGUST 2024

FlightAware

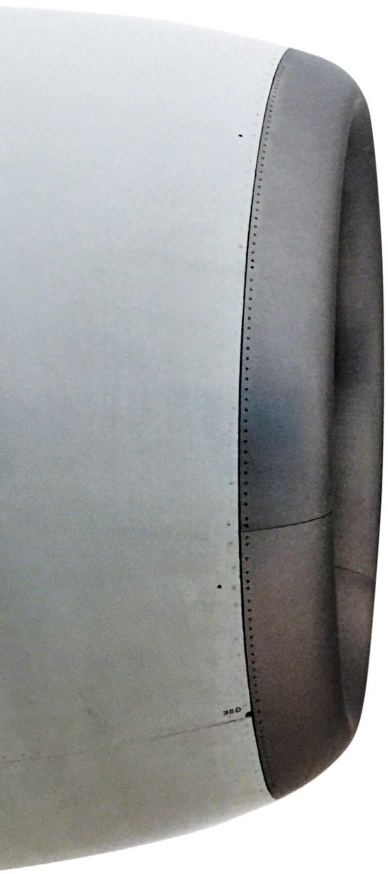
Using Advanced Machine Learning Predictions to Enable Airport Operations

Collins Aerospace
An RTX Business
FlightAware

INTRODUCTION

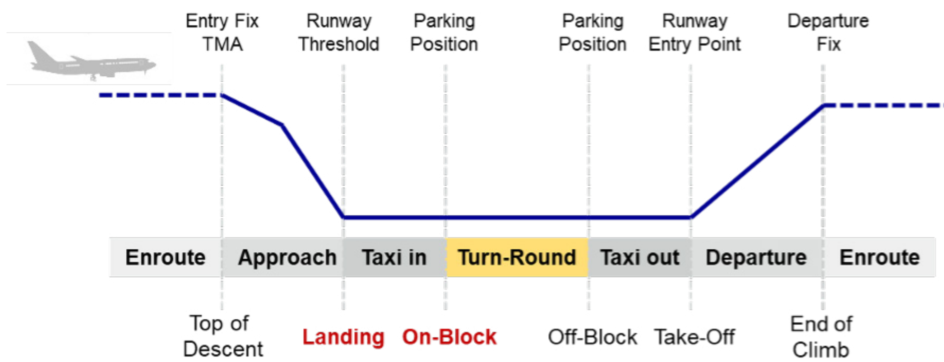
No matter what size airport you're operating, having access to the most accurate flight data is essential for short- and medium-term planning and decision-making. Data quality and continuity are critical for optimizing all the processes that shape operations in and around an airport and its infrastructure—which in turn enhances the passenger experience.

To improve the efficiency of airports, the Airport Collaborative Decision-Making (A-CDM) process requires precise knowledge of the characteristics and timing of inbound traffic. Estimated Landing Time (ELDT) and Estimated In-Block Time (EIBT) are the two most important data points because they trigger all subsequent processes that enable operational efficiency. Armed with more accurate data, operators can better manage the elements of turnaround time, such as stand and gate occupation, and dispatch ground staff for unloading luggage and transferring passengers for connecting travel.



The challenge of getting accurate incoming flight information

Currently, airports rely on third parties, such as airlines and air navigation service providers, for updates to initial flight plans. This can create challenges for achieving the necessary level of data quality and continuity to keep operations running as efficiently as possible. Depending on the airport, the operating company may have a relatively precise, in-advance view of the daily traffic from seasonal flight plan conferences, but any ad hoc traffic only becomes known to the airport once the respective flight plan has been submitted.



However, issues arise when submitted information is incomplete or deviates from the original flight plan, for example, regarding timing or the use of a different aircraft type for the flight. Delays an aircraft accumulated during earlier flights in the day, whether during turnarounds or en route, often remain unknown to the airport operator as well. And the quality of the data connection between the airport and local air traffic control (ATC) can also slow the arrival of this critical information, causing it to only become known after takeoff or shortly before arrival when the aircraft enters the ATC's coverage area.

Delayed or incomplete predictive flight data can negatively impact airport operations in several ways, including:

- Suboptimal use of infrastructure (e.g., aircraft parking stands), leading to reduced capacity
- Inefficient use of resources (e.g., ground staff and ground handling vehicles), which increases costs
- Increase of aircraft delays due to the unavailability of resources

Using data presentation and enabling AI-based decision-making to enhance airport operations

Poor data quality has wide-ranging effects throughout the airport, negatively impacting key performance areas, such as predictability, punctuality, capacity, cost efficiency and quality of service. The more accurate, reliable and predictive the data, the better operators can optimize the usage of airport infrastructure, staff and equipment, which plays a big role in determining the level of service passengers receive.

Use of airport infrastructure

At many airports, aircraft parking stands and terminal passenger gates are a scarce resource, representing potential bottlenecks in the flow of traffic and hindering overall airport capacity. During peak times, parking stand occupation is typically only planned with a 10-15-minute buffer. At major hubs, it's not unusual for one aircraft to enter a stand while another is just starting its engines after pushback from the very same parking position.

Photo courtesy of Fraport Airport

If an incoming aircraft is severely delayed and the airport isn't aware until the last minute, the parking position remains unused until it arrives. If this happens frequently, the airport will be short of positions during peak traffic times, resulting in a requirement for additional parking positions and thus substantial additional infrastructure costs.

In the inverse case, with an unforeseen early arrival of an inbound flight (e.g., due to strong tailwinds), the planned parking position may still be occupied. The incoming aircraft will have to wait at a holding bay or in front of the aircraft stand with the engines idling, producing additional costs for the airline and negative effects for the environment, which is monitored at the airport level for sustainability KPIs.

Use of airport staff and equipment

Qualified staff are an even more critical resource in airport operations, including the employees of ground handling companies. When they regularly have to wait for delayed aircraft to arrive and their equipment remains idle, they have to hire additional staff and get more equipment, with those costs passed onto the airline and passengers. If they don't bring on more staff, turnaround times go up and cascade throughout operations, costing airlines and airports even more.

Quality of passenger service

Any of these reasons for operational delays ultimately result in more flight delays, frustrating passengers who have to wait longer at the gate or baggage claim and potentially miss connecting flights. This decrease in the quality of passenger service ends up costing airlines and airports in the short and long term.

How FlightAware improves the efficiency of airports operations

With airports largely relying on airlines as their source of predictive data, the information they get to make critical operational decisions is generally limited to the seasonal flight plan, updates to it and specific flight plans received each day that contain the aircraft type and number of passengers. This data can reach the airport's operations center via a proprietary link to the airline (usually the home-base carrier), email or the ACARS network. Once the aircraft is airborne, the airport should also receive the ELDT and other information. But the availability and quality of certain data fields often differ a lot depending on the aircraft operator.

An independent, autonomous, real-time, predictive data source powered by machine learning

As an entirely independent source of data, FlightAware provides systemwide coverage of all aircraft equipped with an ADS-B transponder, regardless of the airline or flight origin, significantly increasing data availability for airports. Unlike ACARS messages, which are often generated manually at outstations, data from the FlightAware stream comes precleared in a uniform format and is enhanced by specific algorithms, greatly increasing quality as well. The data goes through a process that takes into account tens of thousands of messages per second, not just ADS-B data but other sources too, referencing it against petabytes of machine learned data to achieve unparalleled accuracy.

FlightAware produces predictions for ELDT, EIBT and other A-CDM milestones through a product called FlightAware Foresight℠ that leverages a neural network of historical flight data. FlightAware Foresight continually assesses key aircraft parameters (aircraft type, speed, heading, position, weather, etc.) in real time, automatically calculating predictions from the moment an aircraft takes off, anywhere in the world, and delivering them over the same Firehose application programming interface (API) that delivers all other flight information. This enables FlightAware to produce much more accurate data than legacy systems, hours before arrival. And by using data from many different sources, FlightAware helps airport operations be more resilient when particular systems or data sources are disrupted.

FlightAware versus legacy data

FlightAware data is highly trusted in the industry because it is rigorously screened for quality; utilizes ADS-B and assesses it against other sources, such as ANSP feeds, radar, MLAT, SWIM and others; and is sent over a single, secure API link rather than through multiple sources. This provides a complete, real-time, dependable picture airports can use to bridge data gaps instantly, understand what is happening with all inbound flights and optimize their operations accordingly.

By blending real-time data with machine-learning capabilities, FlightAware is able to automatically and continually update ELDT and EIBT predictions, giving airports hours longer than legacy data to adjust to evolving flight information. And with a global view of the aviation ecosystem, FlightAware's standardization of data quality and accuracy can benefit entire airport groups.

Proven results: Lima Airport trial

The Fraport Group, one of the leading players in the global airport business, has been benefitting from FlightAware's predictive capabilities at Frankfurt Airport in Germany since 2019 and wanted to leverage the proven results at another airport in their group, Jorge Chavez International Airport in Lima, Peru (Lima Airport). In cooperation with the local operator, Lima Airport Partners (LAP), as well as Fraport, FlightAware set up a proof of concept for the usage of ADS-B, both real time and predicted, to complement and enhance the currently available operational data for the Airport Operations & Control Centre (AOCC) and the newly launched Apron Management Services (AMS).

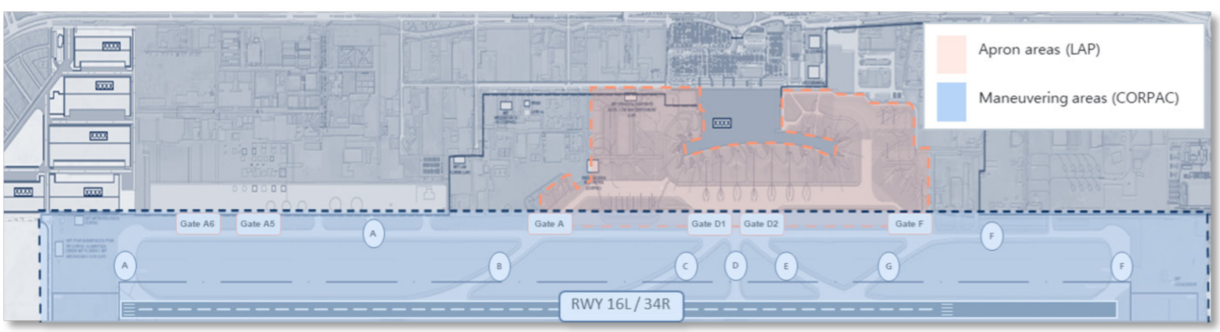
Current situation

Lima Airport grew its passenger traffic from four million in 2001 to 23.6 million in 2019, growing at an average rate of 10.25% per year, making it the third busiest airport in the region. As a result of this constant growth, during peak hours, the airport's airside and terminal facilities have come close to saturation, resulting in a lack of physical resources, such as passenger gates and aircraft parking positions. This spurred a major expansion program, including the construction of a second runway, a 210,000-square-meter terminal building capable of serving 30 million passengers per annum and a new ATC tower.

Fraport's subsidary LAP decided to take over AMS from the local ATC provider to ensure efficient management of the airport's parking positions and reduce delays at the airport. An analysis performed by the project team clearly showed that, for many flights, the current data from the airport operational database (AODB) was lacking the required quality and availability, and there was no aircraft position data (air and ground) available for the situational awareness of the apron operators.

The key data requirements for the operations can be summarized in three points:

- Reliable and accurate predictive data in the local system environment (AODB)
- Reliable and accurate actual time stamps in the local system environment (AODB)
- Availability of ground situation data to display to apron operators



Proof of concept overview

To evaluate the potential benefits from the integration of FlightAware data into the daily operations at Lima Airport, a proof of concept (PoC) was set up onsite, incorporating two main scopes:

1. A display of the FlightAware data for the apron operators as an alternative data source, with the aim to receive detailed feedback regarding the perceived quality and usability of the data
2. A scientific analysis of a one-month data sample from the FlightAware data stream compared to the equivalent data from the AODB at Lima

The entire PoC was scheduled for a duration of one month.

The first scope was mainly achieved by providing three additional screens at the backup ACS working position on wheel-based support stands, which displayed different data from the FlightAware feed.

- Screen 1: FlightAware TV Arrivals and Departures view
- Screen 2: FlightAware Foresight dashboard
- Screen 3: Ground display with the respective API locally integrated in a map-based system

The PoC was initiated by presenting the nature and the capabilities of the various displays to key staff members with the intention that they would brief the staff on duty. At the end of the trial period, several structured interviews were performed with administrative and operational staff to assess the quality and added value of the different data streams.

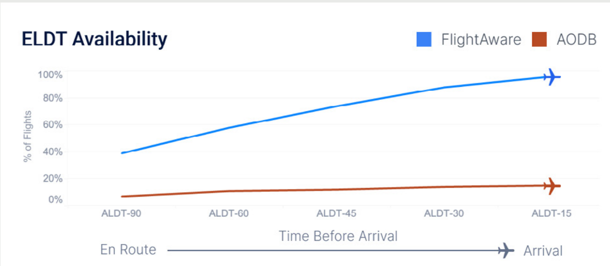
The second scope was achieved by recording data from both FlightAware and the local AODB over the PoC period. At the end of the trial, this data was matched and evaluated in accordance with previously defined measurement criteria in Frankfurt by a team of data analysts and operational experts from Fraport. The overall analysis of a period of almost two months considered a total of about 18,000 flights, which were merged into a two-step procedure (via flight number and Scheduled In-Block Time).

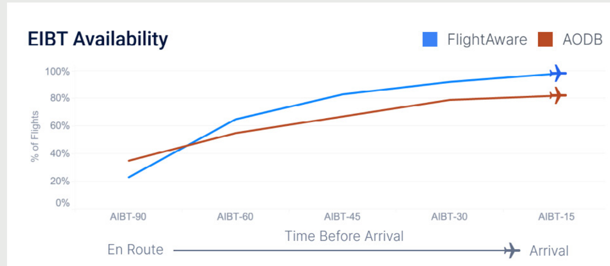
The main objective of the analysis was to measure the availability and quality of the ELDT and EIBT at certain points before the Actual Landing Time (ALDT) of the flight. These were analyzed from as far out as 300 minutes before the ALDT (where applicable) and up to five minutes before.

The result of this analysis is particularly interesting for ACS, since the operators currently do not have a data feed from CORPAC and the AODB is the only available source of predictive data. This will become even more important as of December 2024, when the service will be moved to a Digital Apron Management Centre with no direct vision on the airfield, making situational awareness critical.

Results

Data availability: The first focus of the data analysis was the availability of predictive and nonpredictive data for the evaluated flights. It showed that the availability of ELDT at different times before landing is several times higher in FlightAware than in the local AODB, whereas the availability of EIBT at different times before landing is slightly higher in the local AODB than in FlightAware.



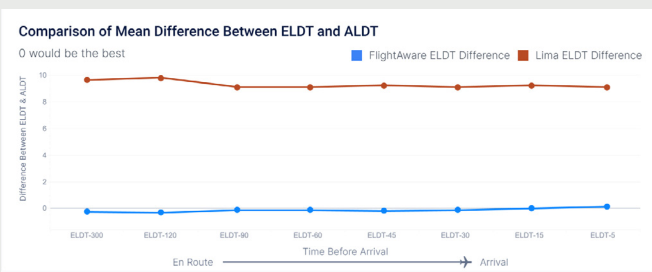


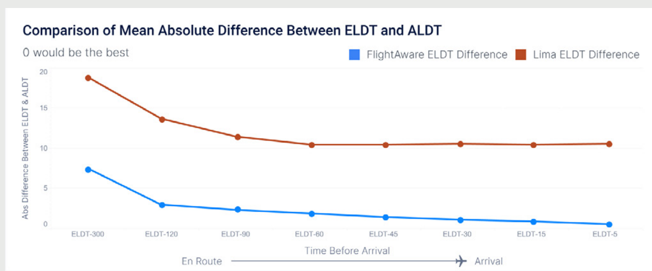
Since the EIBT is generally a time stamp which is derived from the ELDT by adding the estimated taxi time, the availability of EIBTs in the AODB for many flights which do not have an ELDT suggests a misinterpretation of the data, meaning that the original ELDT had been registered as an EIBT in the system.

Furthermore, the data availability of ALDT, aircraft registration and flight origin is very close to 100% in FlightAware, whereas the AODB did not record a registration for around 1.5% of the flight movements.

Data quality: For ELDT, the mean deviation between it and ALDT is eight to 10 minutes in the AODB, whereas it is less than one minute in FlightAware. The standard deviation between ELDT and ALDT is also many times smaller in FlightAware than in the AODB.

Regarding EIBT, the mean absolute deviation between it and AIBT is 11-18 minutes in the AODB, but it is only one to seven minutes in FlightAware. The standard deviation between EIBT and AIBT is many times smaller in FlightAware than in the AODB.





The above graph clearly shows that, even as far out as 300 minutes prior to landing, average FlightAware estimates are more accurate than the AODB's five minutes before landing.

Compared to the mean and standard deviations, the outliers in the estimates are even more interesting from an operational point of view, since they represent the worst-case scenarios for the unnecessary blockage of resources.

The deviation between ELDT and ALDT, as well as EIBT and AIBT, were evaluated for a two-month period, using a time stamp of 30 minutes prior to the respective event. The following table shows the number of flights with deviations larger than 15 and 30 minutes.

Whereas predictive data inaccurate by 15 minutes is operationally problematic and may cause disruptions (e.g., stand conflicts), any data inaccurate by 30 minutes or more at 30 minutes before the event is useless and misleading. The analysis has shown that the use of FlightAware data has reduced these outliers to an absolute minimum versus the regular AODB data.

Deviation (estimate/actual)	**Data field**	**Number of flights** (30 min. before event)	
		Lima AODB	**FlightAware**
>15 min.	EIBT	>1,000	<100
	ELDT	>200	6
>30 min	EIBT	>100	1
	ELDT	100	0

Conclusion

The accuracy and reliability of FlightAware data was statistically proven over the two-month, 18,000-flight trial at Lima Airport. With a complete, real-time picture of all inbound aircraft hours from arrival, operators can confidently make strategic decisions about aircraft parking positions, gate utilization and equipment use that can increase operational efficiency throughout and around the airport.

FlightAware's at-a-glance data presentation and AI-based decision-making capabilities enable operators to predict and solve problems before they even occur, leading to better apron management, staffing decisions and turnaround times. The Fraport Group's independent analysis demonstrates how FlightAware can be an operational game changer that can enable A-CDM practices and unlock whole new levels of efficiency.

Visit Collins Aerospace to learn more.

Collins Aerospace

collinsaerospace.com