Real-time flight path optimization at Volaris

Luis Fernandez, Fuel Efficiency Manager, Volaris and **David Rytter**, CEO, AVTECH share leveraging a flight profile optimizer solution for eco-efficiency flying

Case studies are valuable because they not only tell readers about the product but also relate a story of how the product was implemented and performed in an airline environment. So, before diving into the topic for this case study, let's first take a look at the subject airline, Volaris.

VOLARIS

Volaris (figure 1), the largest Ultra-Low-Cost Carrier (ULCC) in Latin America, flew 33.4 million passengers on 245 routes in the twelve months to June 2023.

Figure 1

The fleet includes 124 aircraft, most of them neo models, serving 71 airports on three AOCs (Air Operator Certificates); one in Mexico, one in Costa Rica and one in El Salvador.

Now we'll look at the solution that has delivered real and measurable savings and efficiency gains to Volaris.

> "The fleet includes 124 aircraft, most of them neo models, serving 71 airports on three AOCs (Air Operator Certificates)..."

AVTECH CLEARPATH

AVTECH designed ClearPath to be an advanced in-flight optimization capability that integrates very smoothly into the user airline's existing operation (figure 2). The system operates as a ground-based service and utilizes already installed technology and therefore requires no investments.

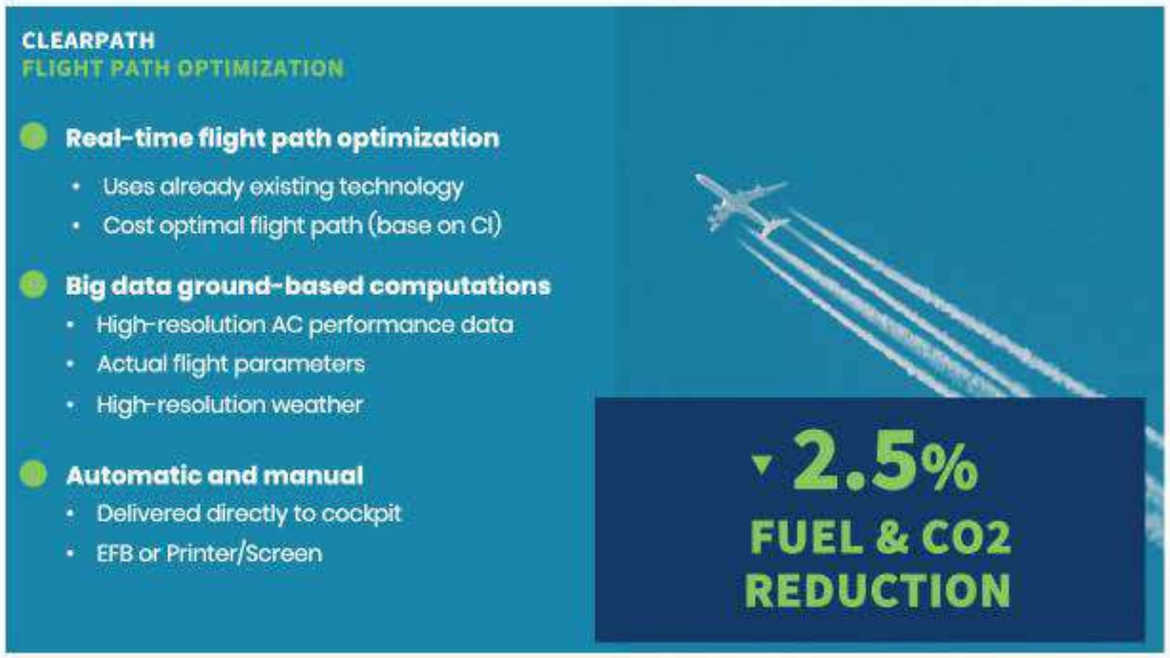

Figure 2

The solution

Airlines can utilize the equipment they already have, and pilots can continue to fly in the same way they currently do, interacting with the FMC (Flight Management Computer) as usual. ClearPath calculates a cost-optimal flight path based on the cost index, aircraft gross weight and route, as downloaded from the FMC in-flight.

As the service is ground based, it is able to perform its flight optimization calculations with unlimited computational resources and full access to the latest accurate high-resolution weather forecasts (figure 3).

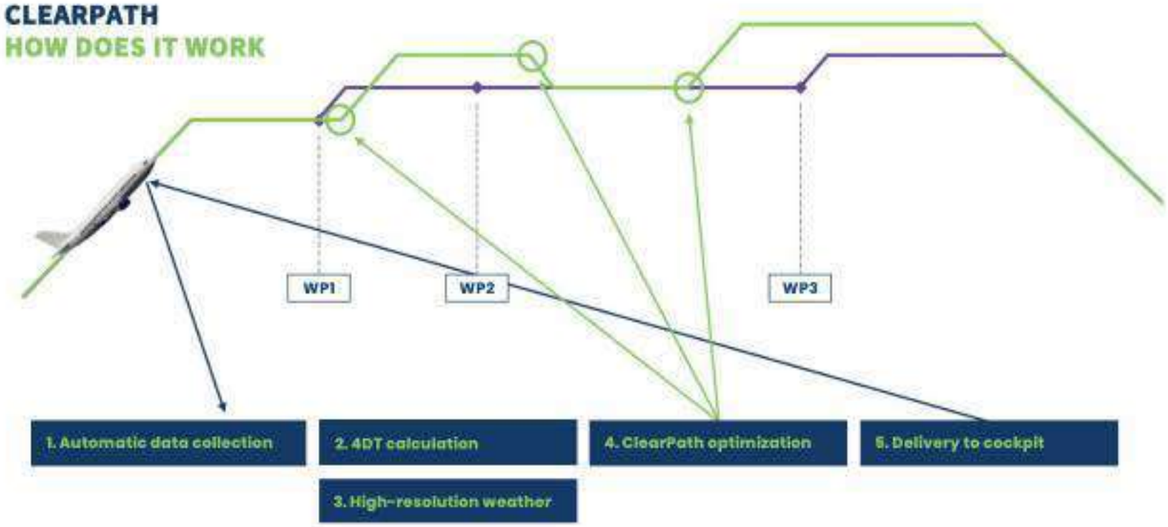

Figure 3

The service is fully automatic and starts by collecting data from the flight such as active route, aircraft gross weight, the selected speed or cost index.

Using this data, a four-dimensional flight trajectory is calculated and used to retrieve a high-resolution weather forecast for the specific flight path. ClearPath then calculates the cost optimal flight profile by comparing all different flight level options to fly from point A to point B.

"...a four-dimensional flight trajectory is calculated and used to retrieve a high-resolution weather forecast for the specific flight path. ClearPath then calculates the cost optimal flight profile..."

The resulting optimal flight path is up-linked to the cockpit in real time, together with information about estimated savings. This means that it's entirely hands-off for the pilots to get this information and then it's up to them to use it to optimize the flight.

For each flight, the service automatically looks at how the ClearPath optimized profile compares with the fuel burn time of flying the original flight plan (OFP) planned flight profile altitude steps. This fuel saving potential is typically around 2.5 percent, however this varies with airline and operation.

How the system works

After take-off, the system monitors the flight and automatically uplinks the information to the pilots. ClearPath requests certain parameters from the Flight Computer, such as the active route, the cost index and the weight of the aircraft.

The solution does a 4DT (four-dimensional trajectory) calculation using the high-resolution weather forecast from the Met Office. This is a full 10k resolution weather forecast with hourly temporal resolution, compared to the standard 140km resolution weather forecast that you see in flight planning. The solution works with the full trajectory and does the ClearPath optimization, calculating the most cost optimal flight profile. The system then calculates what altitudes will give this flight, in this atmosphere with this weight, the most cost-optimal flight profile, then creating a short message uplink to the cockpit.

How ClearPath supports pilots

Figure 4 shows a typical ClearPath message, uplinked to the pilot. This message can be tailored to the airline's preference.

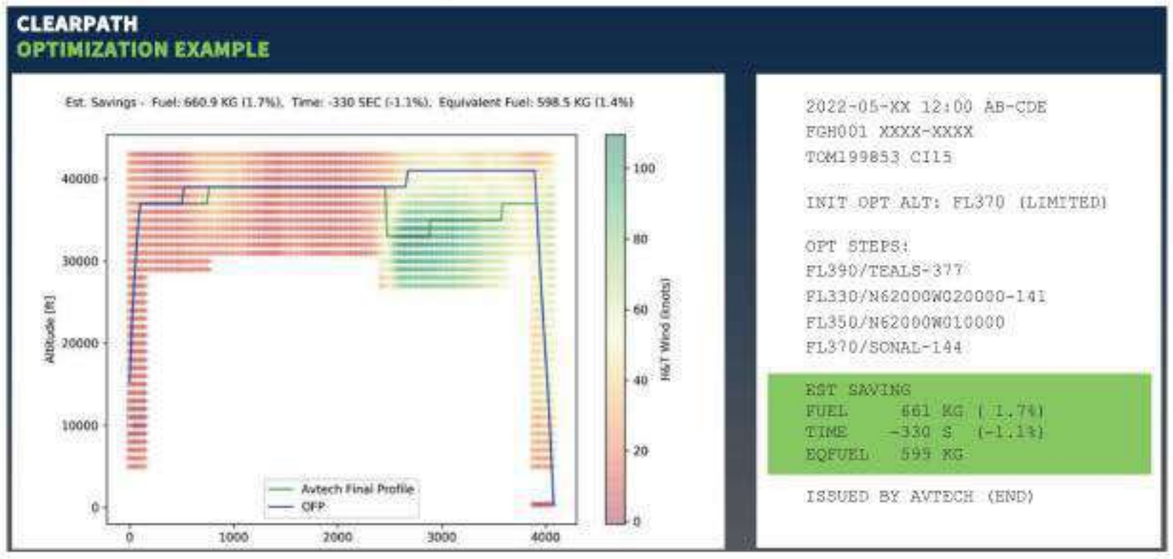

Figure 4

> "This translates to a fuel saving of 1.7 percent of the total cruise fuel consumption, with the trade-off being a slight delay in arrival time..."

Let's take a closer look at ClearPath in action during a Boeing 787 flight across the Atlantic. In the illustration, we can observe the operational flight plan profile represented by a blue line. Towards the end of the flight, as the aircraft approaches Europe, a typical planned step climb is depicted. Furthermore, the illustration highlights a jet stream core located over Europe, which brings advantageous winds at lower altitudes.

On the right side of the screen, we are presented with a ClearPath text message that was received by the pilots during the climb phase, around FL150. This message provides the optimal initial altitude and step climb recommendations for the specific flight, calculated by ClearPath based on the actual weight of the aircraft and a cost index of 15. In the illustration, the ClearPath advice is depicted as a green line, visually representing the recommended altitude profile.

Since this flight is operating at a low cost index of 15, where fuel efficiency is prioritized over time, the optimal flight path is to descend into more favorable wind layers. The pilots can observe that by following this optimal path, they can achieve a fuel saving of 661 kg and experience a time delay of only five minutes, as compared to flying the originally planned profile.

This translates to a fuel saving of 1.7 percent of the total cruise fuel consumption, with the trade-off being a slight delay in arrival time on an eight or nine-hour flight.

It is worth noting that on this specific flight, the pilots successfully adhered to the optimal path, and upon landing, a report was received confirming the achieved savings. By initiating the service automatically (Figure 5) after take-off, several benefits are achieved. Firstly, it guarantees that every flight undergoes optimization, Additionally, this automated process ensures that the optimization takes into account the precise aircraft parameters, which are extracted by the service directly from the flight computer. This guarantees that the optimization is tailored to the specific characteristics of the aircraft being flown.

ClearPath distinguishes itself from other services in the market by minimizing the workload on pilots through its hands-off and fully automated nature. With ClearPath, pilots receive automatic optimization, leaving them with the primary tasks of coordinating with air traffic control and following the recommended flight profile (figure 5).

Figure 5

Extensive airline case studies have demonstrated that this approach fosters a high level of pilot compliance, thereby maximizing the value delivered to the airline.

AVTECH just launched a brand-new feature in ClearPath that they think pilots, crew and passengers will like (figure 6).

Figure 6

ClearPath has recently incorporated a groundbreaking feature (refer to figure 7) that integrates the detection, notification, and avoidance of hazardous turbulence directly into its optimization process. Going forward, ClearPath will proactively inform pilots about the presence of hazardous turbulence along their route and provide suggestions on the most cost-optimal methods to avoid it. Importantly, this entire process is fully automated, further reducing pilots workload.

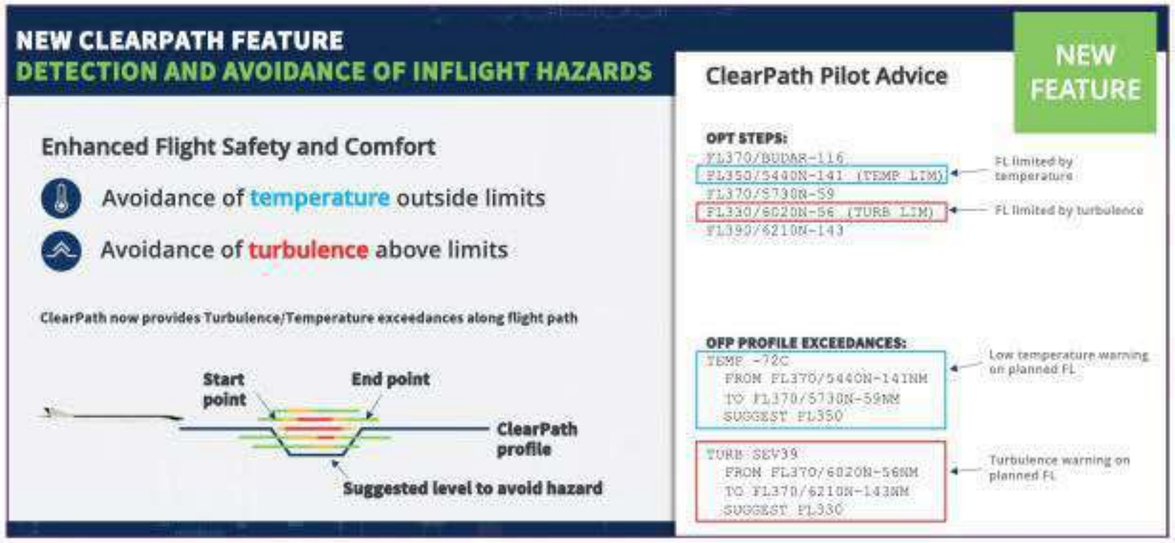

Figure 7

The ClearPath report now lists in a separate section any turbulence and temperature exceedances along the planned flight profile, complete with start point, end-point and intensity, and the ClearPath optimization will now clearly state when optimal flight levels are limited by temperature or turbulence.

ClearPath always shows the most cost-optimal altitudes and step positions to avoid these hazards.

The accuracy of this weather information now truly makes this new feature a game changer for pilots and airlines. The text-based version of ClearPath (figure 8) really makes it easy to get started and get it into the cockpit and used by the pilots while the pilots continue to interact with the FMC.

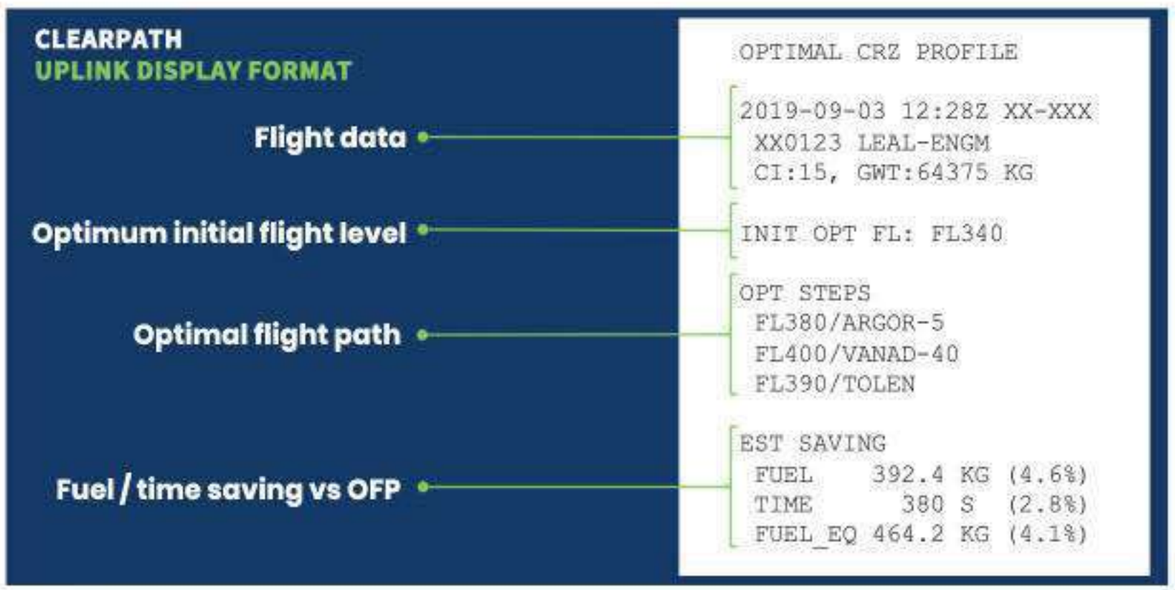

Figure 8

The foundation of this feature lies in the utilization of a highly detailed and accurate high-resolution EDR turbulence forecast provided by the UK Met Office. Leveraging this advanced weather information, ClearPath aims to revolutionize the way turbulence is managed during flights. With this innovative capability, it is anticipated that this new feature will have a significant impact on the industry. ClearPath service offers integration with AVTECH's ProFlight EFB app (Figure 9).

Figure 9

This integration allows pilots to have a more interactive experience, where they can apply constraints on the optimization process and access additional features. However, it's important to note that the underlying optimization algorithm remains the same, ensuring advanced optimization in the background. ClearPath eliminates the need for additional apps or the introduction of numerous new elements. Pilots can continue their operations as usual but now benefit from enhanced guidance and support.

So, let's have a look at how it has worked for Volaris.

CLEARPATH FLIGHT OPTIMIZATION IN VOLARIS

The key question any airline would want to address regarding an optimization service is whether the savings communicated to the pilots are accurate. Volaris provided an answer to this specific question by confirming that ClearPath's savings calculation was reliable and often conservative.

ClearPath savings analysis

To conduct the analysis, Volaris carried out an audit to assess the accuracy of ClearPath's calculations and the projected savings. Five flights were selected for

comparison with the airlines internal Flight Data Monitoring (FDM) system. For the audit, Volaris had to find flights that had been flown with a lateral flight path matching the planned route. Figure 10 illustrates one of these audited flights.

> "ClearPath eliminates the need for additional apps or the introduction of numerous new elements. Pilots can continue their operations as usual..."

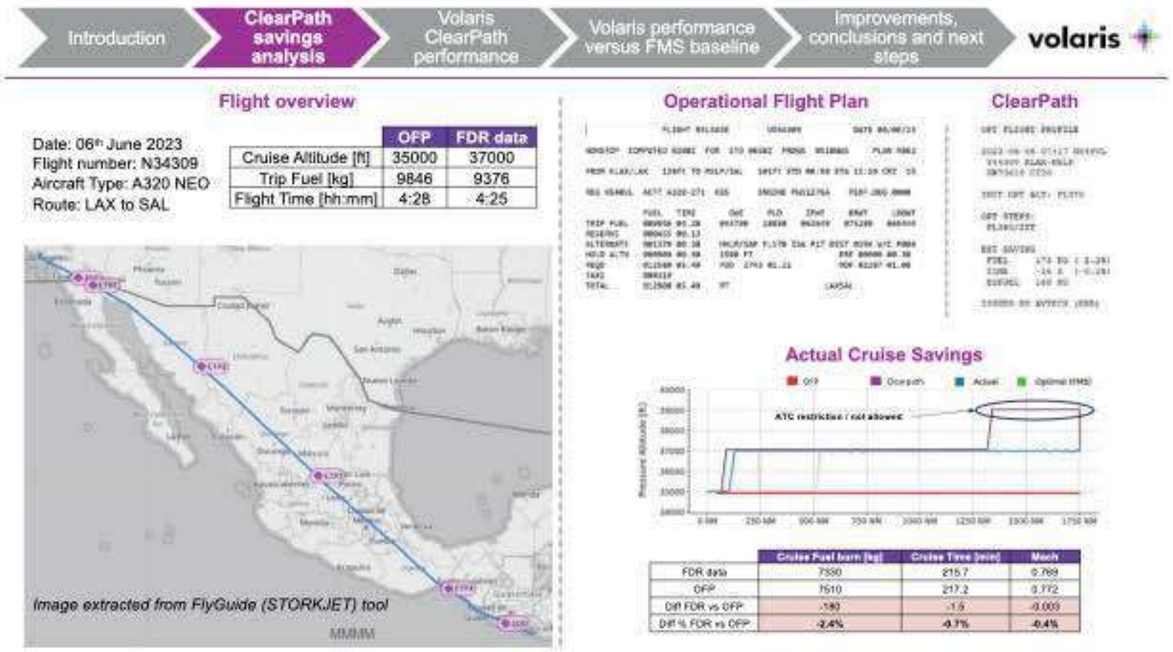

Figure 10

This sample flight was from Los Angeles to El Salvador and was planned at flight level 350. The recommended optimal flight level suggested by ClearPath was FL370, as depicted at the top right of figure 10. In this case FL370 was also selected and flown by the pilots. In the middle right of figure 10 you can see the actual cruise savings and different profiles for the same flight. The red profile is the original flight plan (OFP), the purple profile is the optimal flight level proposed by ClearPath, and the blue profile is the actual flown flight level. In addition the green profile shows the onboard flight management system (FMS) proposed flight level.

On this specific flight the pilots were able to realize most of the savings potential by selecting the more optimal flight level 370. However, the entire savings potential was not realized. ClearPath proposed an additional optimal step to flight level 390 around 1,300 miles from the start of the cruise, but due to other traffic this step was never performed. The validation results, depicted in the table at the bottom right, confirm that the actual fuel saving was 180 kg (2.3%), which aligns closely with ClearPath's estimated savings of 173 kg (2.2%).

ClearPath performance

As a next step, Volaris conducted a performance evaluation divided into two distinct periods, April and May, June and July 2023. Figure 11 presents the final results that were obtained over this four-month period. In total the study comprized a substantial sample size of over 66,000 flights, 40 percent of which were optimized by ClearPath. Among these optimized flights, an average fuel saving of 96 kg per flight was achieved. However, due to limited internet connectivity in parts of South America, ClearPath didn`t always receive the required flight plan inputs. As a result, approximately 25 percent of the flights remained unoptimized.

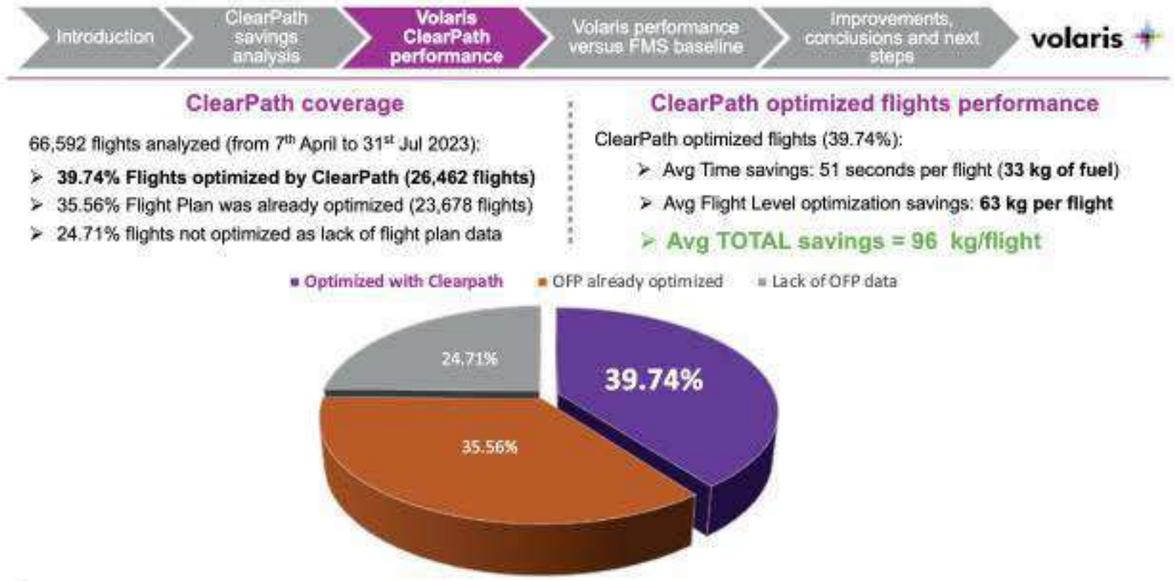

Figure 11

Volaris operates under three Air Operator Certificates (AOCs), prompting a breakdown of results by carrier, as illustrated in Figure 12.

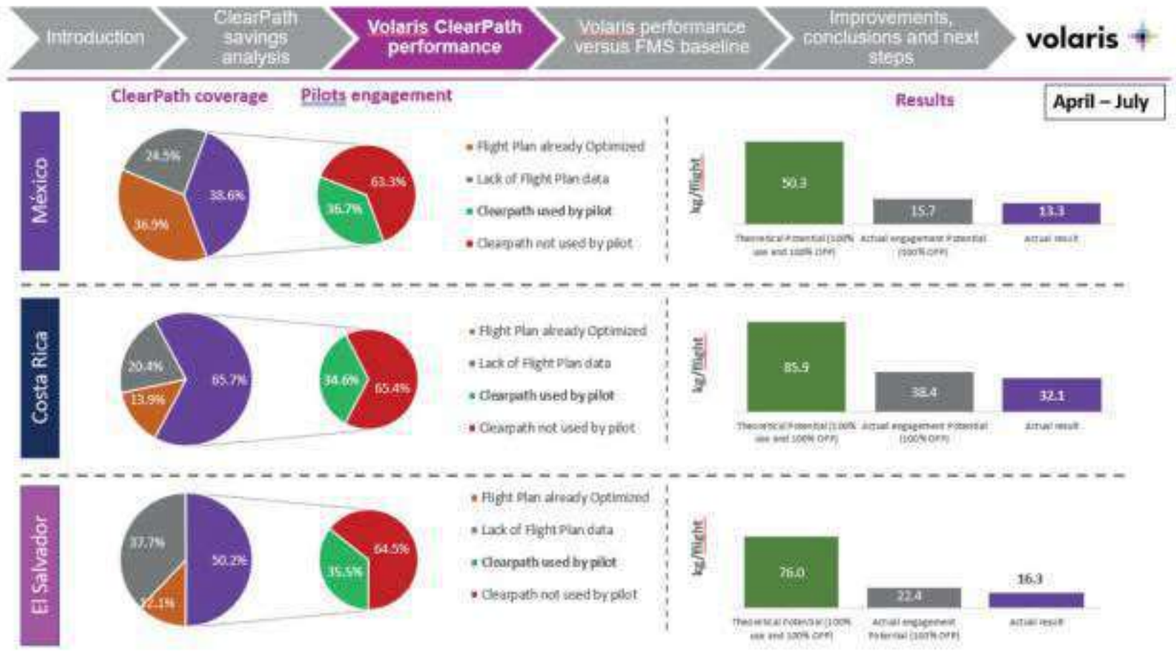

Figure 12

In figure 12, on the right there are three sets of columns. The first one (green) shows ClearPath´s total achievable savings with 100 percent of pilot engagement. The second column show`s the actual engagement potential but excluding cases with missing data. The column in purple shows the actual savings result Volaris obtained for the three carriers.

Volaris's most important AOC is the one in Mexico, with more than 80 percent of Volaris' flights. Flights to Costa Rica present the highest fuel saving potential, especially in the cruise phase, leading to more substantial results. The Pilot engagement level was measured to be just over 36 percent during the period. Typically pilot engagement increases over time as pilots become more familiar with the service and in this case actual savings will also increase accordingly.

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Introduction | Clearpath savings analysis | **Volaris Clearpath performance** | Volaris performance versus FMS baseline | Improvements, conclusions and next steps

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Data Results, based in the ~40% of total flights optimized (26,462 flights)

April – July

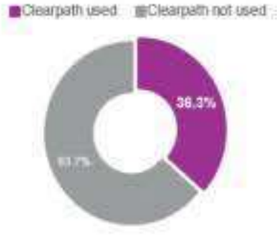
- ~36% of usage/acceptance by pilots (10,580 flights)
- Savings achieved when ClearPath was used:
  - Flight time reduction: 51 seconds (33 fuel kg)
  - Flight Level Optimization: 63 fuel kg
  - **Total = 96 kg/flight**

ClearPath savings per flight

Total savings vs OFP (all flights)

Top 5 Routes optimized by ClearPath	Top 5 Routes where ClearPath was not used	Top 5 Routes where ClearPath was used
TIJ-GDL	MEX-GDL	TIJ-GDL
MEX-CUN	GDL-MEX	MXL-GDL
MEX-GDL	MTY-MEX	GDL-TIJ
GDL-TIJ	MEX-CUN	MEX-CUN
MXL-GDL	MTY-GDL	LAX-GDL

% ClearPath utilization



Absolute % utilization per base

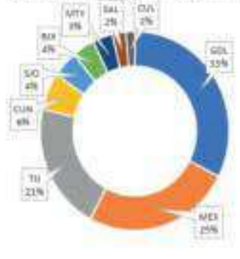


Figure 13

"...more than half of Volaris flights could be optimized by ClearPath with a theoretical savings potential of 63kg per flight..."

Figure 13 illustrates the two periods: April to May and June to July. In the first period, the obtained ClearPath fuel savings was higher than the results of June and July

The furthest right purple column in figure 13, depicts the actual savings, while the potential savings are shown in gray, reflecting what would have been achieved if all OFPs had been passed to AVTECH. In comparison to the original operational flight plan (OFP), Volaris attained a total fuel saving of 14 kg per flight. This part of the case-study reveals that more than half of Volaris flights could be optimized by

ClearPath with a theoretical savings potential of 63kg per flight. When accounting for the real application rate during the evaluation period this resulted in a 14kg actual saving. Taking into account only the 40 percent of the flights (26,000 Flights) in the evaluation period, that were optimized by ClearPath, the average fuel and time saving per flight was found to be 63kg and 51 seconds respectively. This is a total cost saving corresponding to 96kg per flight.

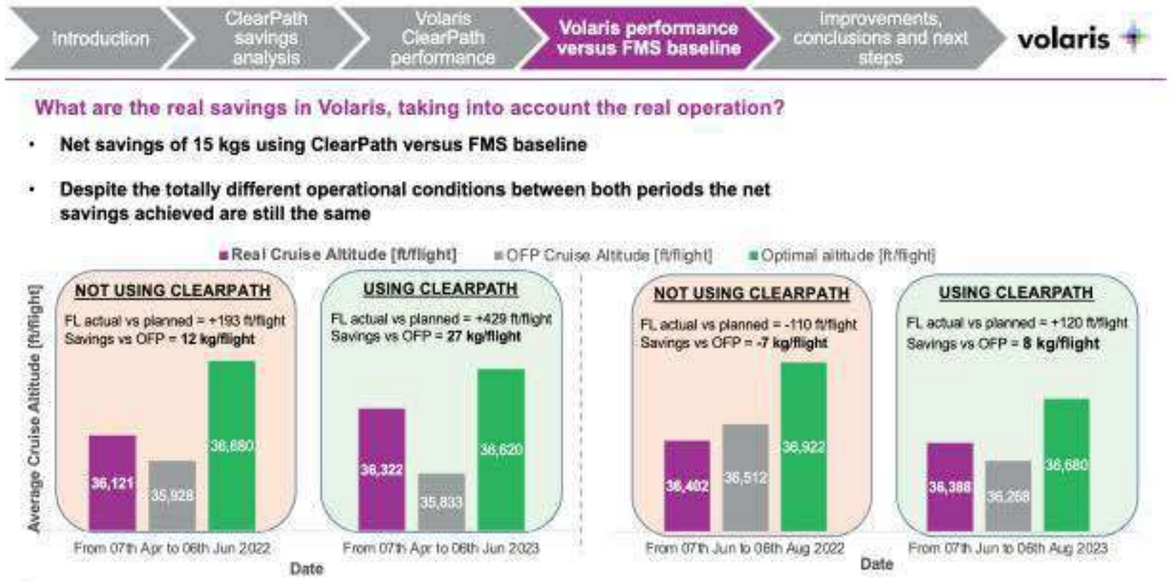


Figure 14

As the final step of the case study, Volaris conducted an analysis of the average altitudes flown before and after ClearPath was deployed. Actual results were compared under similar conditions by using data from the same month of the previous year. Figure 14 illustrates the results of this study, showing a comparison between the actual and planned cruise altitudes. During the first period (April and May), the actual altitude, represented in purple, exceeded the OFP altitude depicted in gray, but remained lower than the optimal altitude shown in green provided by the FMS. In the period of June and July, the actual altitude was initially lower than the OFP altitude. However, with the implementation of ClearPath, this trend has shifted, and the actual flown altitude now consistently exceeds the OFP altitude. Despite the differing operational conditions between the two periods, ClearPath consistently achieved a net savings of 15 kg per flight. These results are similar to and validates the previous study 'actual saving' results of 14kg per flight.

IMPROVEMENTS, CONCLUSIONS AND NEXT STEPS

The greatest challenge when the project started was that all Volaris's aircraft had restrictions limiting the ACARS uplink. The calculations were solely reliant on the OFP data. Resulting in a lack of comprehensive information regarding FMS inputs and pilot performance, which affected the accuracy of flight profile calculations. During the implementation period, and to encourage pilot engagement, Volaris successfully introduced the new ClearPath turbulence and temperature avoidance model.

LUIS FERNANDEZ

Luis is an aeronautical engineer with eight years of experience in airlines' data analytics as FDM and safety data manager, operational cost optimization and fuel efficiency manager. In the past he worked as a mechanical engineer specialized in mechanical and fluid simulations for several years. Currently he and his team are responsible for developing, implementing and monitoring fuel efficiency strategy and reduce the overall operational costs in Volaris.

DAVID RYTTER

David Rytter is the CEO of AVTECH Sweden. Prior to becoming the CEO, he served as Chief Technical Officer leading the development of AVTECH's services. Before that he was also Head of Aventus Nowcast, AVTECH's wind uplink service, and a project manager for different development projects. Not only does he have a great knowledge and experience of AVTECH's products and services he has also flown as a voluntary pilot for the Swedish Voluntary Flying Corps (FKK) since 2006. David holds a MSc in Aerospace Engineering from the Royal Institute of Technology (KTH).

VOLARIS

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Volaris is a low-cost Mexican airline and the largest Ultra-Low-Cost Carrier (ULCC) in Latin America. It is based in Mexico City, Guadalajara, and Tijuana. The airline offers scheduled flights across the Americas, mainly offering domestic flights within Mexico and international flights to the US. The fleet includes 124 aircraft, most of them neo models, serving 71 airports on three AOCs (Air Operator Certificates); one in Mexico, one in Costa Rica and one in El Salvador.

AVTECH

AVTECH

AVTECH specializes in tailored information to the cockpit, offering easy, automated and inexpensive improvements in FMS optimization. ClearPath is a real-time flight path optimization service that uses existing on-board technology, so requires no investment other than the investment in ClearPath itself. The solution calculates a cost optimal flight path based on the cost index (CI) that the pilots have entered into the flight management computer (FMC) with the active flight path, weight and other factors.