HOW NATS MANAGES AIRSPACE EFFICIENCY

BY JARLATH MOLLOY (NATS)

NATS was the first Air Navigation Services Provider to adopt a target to reduce air traffic management (ATM) related CO_2 emissions, committing to reduce it by 10% by 2020, using a 2006 baseline. In 2012, NATS and the UK Civil Aviation Authority (CAA) agreed on a methodology for measuring airspace efficiency. This became known as the 3 dimensional inefficiency, or 3Di, metric. 3Di is a proxy for airline fuel burn and is used as a key performance indicator to help measure progress against the CO_2 emissions target.

For historical reasons, aircraft fly from origin to destination airports along invisible tracks, via fixed individual way points. These tracks can be complex close to airports as they weave to and from runways, around airport communities and up to high-level airspace. If the performance of this system is to be improved and ATM-related CO_2 emissions reduced, a means to be able to measure the airspace performance is needed, which itself is a difficult task.

The 3Di metric came about after discussions with NATS' airline customers on how they would like to see airspace efficiency measured. The CAA and airline customers are interested in NATS' performance and have sought improvements by setting targets. NATS can a earn a bonus or incur a penalty depending on 3Di performance, equivalent to 1% of revenue per year, which is equal to the level of incentives on NATS' delay performance.

The 3Di metric is calculated using a bottom-up approach, whereby every commercial flight, every day of the year (with only 'return to base' flights excluded) will have an individual 3Di score calculated, and these are averaged for the full year. Scores run from 0 (zero inefficiency which is good), to 100+ (lots of inefficiency which is bad). Each year, all the scores are combined to produce a single annual average score for UK airspace and compared to the target.

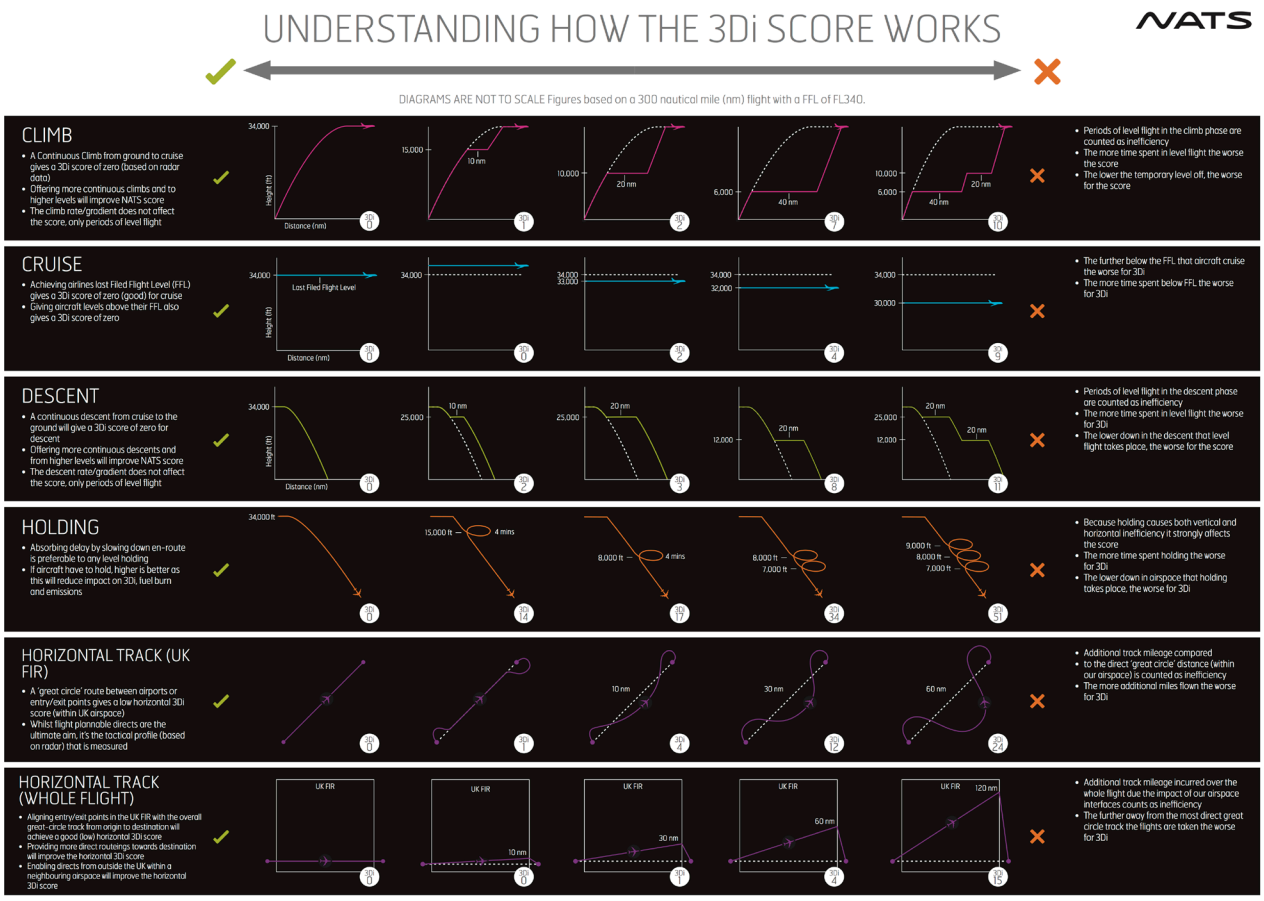
The 3Di metric compares the actual trajectory that aircraft take, based on real radar data, with a theoretical "great circle" or shortest route, together with the airline's requested flight level. The radar data shows how efficient the actual flight was, compared to the minimum fuel burn trajectory and the flight level the airline had originally requested. This comparison is a compromise made to allow the metric to work, but it does help in other ways. For example, opportunities can be identified both inside and outside NATS' airspace where changes can be made or supported elsewhere that improve the overall performance of the network.

Each flight is scored according to six categories; level flight in i) climb, ii) cruise and iii) descent, iv) holding, v) horizontal track (UK) and vi) horizontal track (whole flight). Depending on the category and the extent of the sub-optimal profile, each flight will accrue 3Di points. This helps identify hotspots where airspace is not performing as well as it could. NATS then reviews why this is the case, e.g. there could be very good reasons for a restriction or procedure to be in place for safety or capacity reasons. In other cases, NATS might discover something that a Standing Agreement no longer required and will remove it. ATM related CO_2 emissions are reduced and the 3Di score improved by delivering more aircraft closer to the airlines' preferred flight trajectories, which includes:

- More continuous climb and descent operations to/from higher levels
- More direct routes across UK airspace
- Reduced airborne holding at destination airports
- Working with neighbouring air navigation service providers, military and general aviation airspace users to deliver more direct routes across the whole flight profile
- Achieving airlines' preferred cruise levels
- Working to improve the score from the previous year by looking at all aspects of inefficiency, whether caused by NATS or others and working collaboratively to reduce it.

Together with British Airways, Heathrow and Edinburgh Airports in 2010, NATS tested a "Perfect Flight" concept. Every factor within the journey from push back off the stand and taxiing, to optimised flight profile and continuous descent approach was calibrated to achieve minimal CO_2 emissions. The 3Di score for the perfect flight was 1.4 points; there was no vertical inefficiency and the score was directly attributed to the noise preferential routes on departure from Heathrow and manoeuvring on to final approach at Edinburgh. No flight will ever have a zero score and there will always have to be some inefficiency in the system due to runway direction and weather conditions, and of course, the need to maintain separation of traffic to ensure safety is uncompromised.

Only by gathering and analysing huge amounts of radar data from across the network over time is NATS able to obtain a real understanding of how it is performing in the delivery of services to its customers. Ultimately the 3Di metric allows NATS to track its performance and identify opportunities to reduce air traffic management related CO_2 emissions, while at the same time reducing airline customer fuel costs.



The 3Di methodology has evolved since inception to take account of improvements to data and analysis of performance. As a result, the CAA and NATS have agreed on revisions to the methodology and baseline. NATS' performance and progress to 2019 will be measured against whatever happened in the updated 2014 baseline (e.g. ATM strike days, bad weather days, runway closures, repositioning, diverts, holding issues), to be able to measure performance consistently.

The CAA has set annual targets for NATS which are broken down across control centres and airport units, based on traffic levels and the 3Di baseline. NATS includes all UK airports even if an ATM service is not provided there, and non-NATS controlled airspace (i.e. uncontrolled and delegated airspace). In turn, NATS is able to split the score and target across individual airspace sectors and review progress across controller shift patterns, which is helpful to identify and share best practices.

NATS' air traffic controllers are able to analyse the environmental efficiency of flights in near real-time, thanks to a Flight Optimisation System, or 'FLOSYS', which takes real radar data, updated every three minutes, and combines it with NATS' 3Di airspace efficiency metric to produce a graphical representation of every flight in UK airspace. Controllers can then analyse the efficiency of an individual aircraft through every phase of flight and airspace sector, as well as compare it against other flights along the same route, up to 12 months ago, including the average and best performing. By having access to this granularity of data, controllers and airspace managers are able to better identify the opportunities for operational improvements that will save our airline customers fuel and reduce air traffic management related CO_2 emissions.

The 3Di metric isn't perfect; it's not an academic research project designed in a lab – it's a metric developed using near-time operational data which must be responsive and dynamic. There are a number of simplifications and assumptions built in to the metric to make it work, given the volume of data from the 2.2 million flights handled annually. NATS seeks to be honest about what it can and cannot do, and have highlighted what it was designed to do from the outset. Indeed, some of the recent improvements have been based on constructive feedback received from controllers, and some of it is based on lessons learned. 3Di has been exceptionally useful in helping to identify, challenge and resolve inefficiencies in airspace. The monthly 3Di scores are reviewed by NATS senior management, and NATS continues to work with its controllers, customers and other stakeholders to identify opportunities and solutions to improve the score. NATS also regularly reports to its customers, regulator and with the public on progress against the 3Di targets.

The alternative EUROCONTROL KEA (average horizontal en route flight efficiency) metric is useful to benchmark performance across NATS' European peers; however, as with

any metric, it also has its weaknesses. For example, KEA is limited to the portion of the flight trajectory beyond a 40 nautical mile circle around departure / arrival airports and does not capture airspace inefficiency close to airports, e.g. in the London Terminal Manoeuvring Area. KEA also does not cover vertical profile inefficiency. The 3Di metric shows that in 2015, 80% of the inefficiency in UK airspace fell within the 40 nm zone near airports, while 26% of the inefficiency in UK airspace was vertical.

NATS' 3Di metric and the alternative EUROCONTROL KEA metric both support measurement of operational performance. This enables air navigation service providers to identify areas for impermanent and to benchmark their relative performance. The metrics additionally are useful to help measure the environmental benefits of implementing various Aviation System Block Upgrade (ASBU) modules, as part of the ICAO Global Air Navigation Plan.

The improvements made to airspace efficiency, even if quite small, cumulatively add up to significant savings for NATS' airline customers in terms of delay, CO_2 emissions and fuel. It is a complicated relationship, which is why airspace performance is managed separately with its own targets. NATS' initiative has been recognised across the industry and received the "Sustainable product and service award" from BITC in 2014 and was re-validated in 2015 after demonstrating further improvement.

NATS is grateful to all those who have contributed to the success of 3Di, including its airline customers and regulator. NATS has demonstrated the potential of 3Di and FLOSYS with a number of other Air Navigation Service Providers and is happy to continue sharing its experiences with other stakeholders across the industry to improve the network's efficiency and reduce ATM related CO_2 emissions.

Figure 1. UK domestic flight profile

Figure 2. UK overflight profile