EUROCONTROL

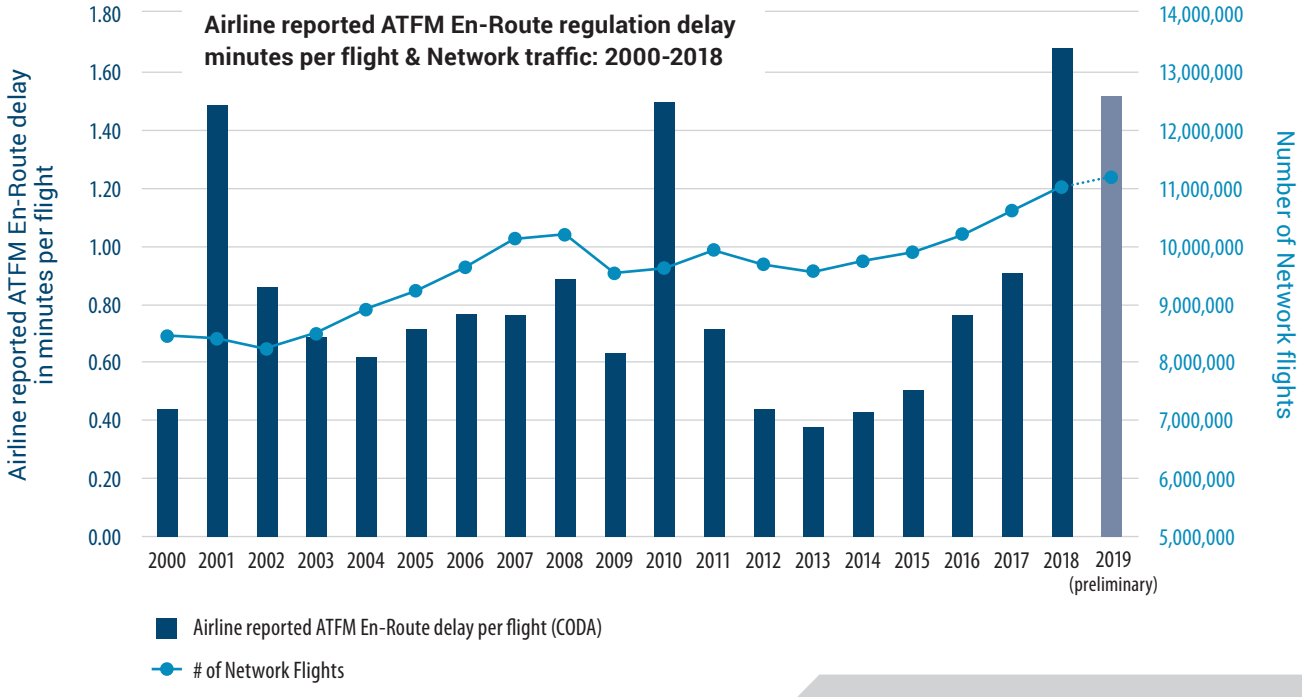
ATFM Regulation: a power for good
Understanding how it works

You've just boarded your flight. The pilot announces that boarding is complete, but the aircraft will have to wait another 20 minutes at the parking position because "*we have an ATC delay*". Sounds like a problem? Relax. This means the EUROCONTROL Network Manager's flow management system is working: ensuring that an air traffic controller somewhere along your flight path doesn't suddenly have too many aircraft to deal with; smoothing out the peaks and troughs in demand. It's both safer and better for the environment for your aircraft to wait here on the ground rather than having to hold in the air over the destination airport. Meanwhile, the pilot, the airline operations centre and the Network Manager Operations Centre (NMOC) are working to find the best solution.

2018 saw record numbers of flights in Europe but, as the graph shows, it was a dreadful year for ATC delay. Despite everyone's best efforts, weather and staff shortages conspired to take delays and cancellations sky high. This year, the Network Manager has coordinated a set of seven intensive measures to ensure that, even with more traffic growth, Summer 2019 is not worse than 2018. Coupled with investment in backup capacity by airlines, so far the results are looking at least marginally better than 2018.

Amongst the millions of passengers facing ATC delays, there are some lucky ones. Your pilot might continue to say that, despite the ATFM (air traffic flow management) regulation, the flight is still expected to arrive on-time at the destination, ensuring that all flight connections will be made. An ATFM regulation is often called a 'slot delay'. Sometimes the impact of an ATFM regulation is limited to what it was designed for: to ensure safe and smooth air traffic operations. Indeed the data show that in 2018 more than a third of flights with an ATFM regulation of up to 20 minutes, as in our example, still arrived on time at their destination.

But how can this be true? Here in 2019, with air traffic delays much higher than they should be, we cast light on two parallel worlds: of flights and flight plans; and of passengers and their ticket times. We explain where the worlds touch, and how they interact for the good of both.



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Two types of delay measurement

ATFM regulation (delays) and the passenger experience of delay (all-causes delay) are not the same; they both measure a time difference, but from a different perspective.

ATFM regulation: Too many aircraft in the air at the same time and in the same place can lead to an unsafe situation, an 'overload'. One of the tools used by the Network Manager Operations Centre (NMOC) to prevent this from happening is to 'regulate' a flight, by issuing a calculated take-off time (CTOT) - a 'slot'.

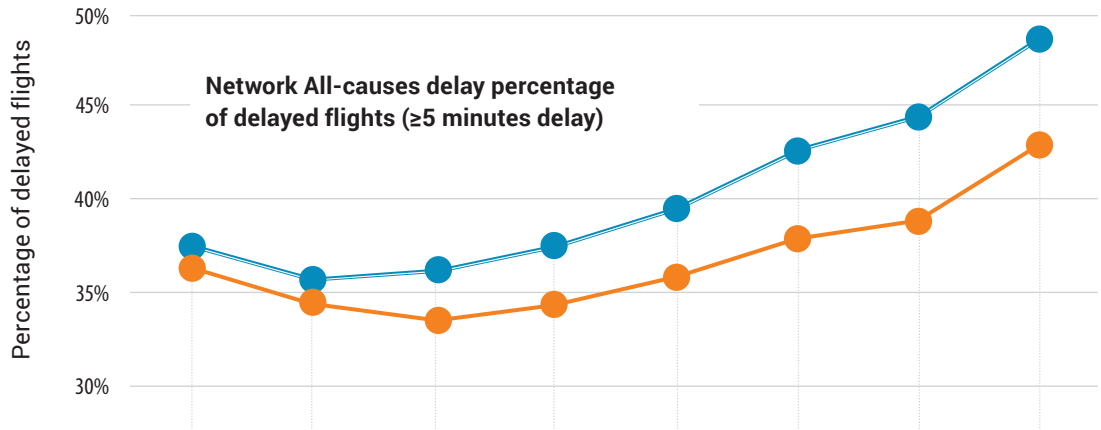
Normally, regardless of what is on its flight plan, a flight asks local air traffic control for permission to leave as soon as it's ready. In Europe, (EUROCONTROL's area of operations), issuing a CTOT creates an ATFM "slot" that restricts when the aircraft can depart to a narrow window between 5 minutes before and 10 minutes after the CTOT. The aircraft is required to be at the runway, ready for departure during this window. The few minutes of leeway are to allow air traffic control to integrate the aircraft safely into the other traffic.

With an ATFM slot, aircraft are kept on the ground at the departure airport to avoid a predicted traffic overload somewhere along the aircraft's flight path. The 'bottleneck' that triggered an ATFM regulation can be at the destination airport, in an en-route sector, or at the departure airport but will always result in keeping the aircraft on the ground at the departure station.

Some may be surprised to know, for example, that a departure delay in Istanbul may be incurred because bad weather is expected at the destination in London, 3 hours later, even though the weather in Istanbul is good and there is no congestion.

But the departure airport is just where the delay is taken, not the cause of the regulation. The real cause could be at either airport, or capacity limitations in the airspace between the two airports, en-route.

"A key tool is to regulate a flight by issuing a calculated take-off time (a 'slot')"



	2011	2012	2013	2014	2015	2016	2017	2018
Delayed Departures	37.2%	35.5%	36.1%	37.4%	39.6%	42.5%	44.4%	48.4%
Delayed Arrivals	36.3%	34.4%	33.6%	34.3%	35.8%	37.7%	38.7%	42.8%

The effect of the ATFM regulation is measured in minutes as the difference between the airline's requested take-off time (in the flight plan) and the CTOT issued by the EUROCONTROL Network Manager. This value remains unchanged regardless of the actual recorded take-off time of the flight concerned.

ATFM regulations are used sparingly. Even when they are used, half of all regulations are in effect just saying 'make sure you take off as in your flight plan' so have no delay effect at all; to avoid an overload the Network Manager just needs the flight to follow its plan more closely.

In 2018, just 11% of European flights had an ATFM regulation of more than 5 minutes; half of these between 5 & 15 minutes and the other half more than 15 minutes. Curiously, around 25% of the ATFM regulation minutes had no negative effect on the arrival punctuality of a flight; on the contrary they often push a flight to arrive closer to the scheduled arrival time because the aircraft was flight planned to arrive ahead of the scheduled time of arrival.

In contrast to ATFM regulations, all-causes delay is often referred to as the 'passenger experience' of delay. It compares the actual time the aircraft departed or arrived on the parking stand (physical movement of an aircraft) against the commercial schedule that the passenger was shown when she bought the ticket. All-causes delay is based on a schedule that typically has been fixed months in advance. Very different to ATFM regulations, which are compared to a flight plan, and the airline can make several updates to the requested take-off time in the flight plan even on the day of the flight.

As a passenger you can easily measure the all-causes delay: it's the difference between the times printed on your ticket (or in your flight booking) and the actual time the aircraft moved away from or arrived on the stand.

"Airlines often apply schedule buffers to mitigate expected departure delays"

Airlines focus on arrival punctuality

Within all-causes delay, in recent years airlines have increasingly put their operational focus on arrival rather than departure punctuality. Late arrival may cause passengers to miss their connecting flight, it causes reactionary flight delays and under EU law a very late arrival may trigger financial compensation to passengers (EU regulation 261/2004).

Evidence for this shift of focus is that the share of delayed departures (≥5 minutes compared to the schedule) has been increasing at a faster rate than the share of delayed arrivals. In 2011 the difference between the share of delayed departures and the share of delayed arrivals was less than 1%. By 2018 this difference had increased to more than 5%, indicating that the airlines are managing to maintain their arrival punctuality better than departure punctuality.

Securing a flight's on-time departure remains the best starting point for an on-time arrival but many airlines also apply schedule buffers to mitigate expected departure delays: a little extra time in the schedule compared to the expected flight time, just as a passenger might leave for the airport a little early, in case the bus gets caught in traffic. Schedule buffers are an easy fix for improving arrival punctuality, they mean that an aircraft can still arrive on-time despite a delay on departure. However, since the schedule is fixed for a whole summer or winter season at one go, they're a sledgehammer solution rather than a scalpel: for example, schedule buffers can reduce the arrival delay but they also cause aircraft to arrive ahead of schedule on those days when there is no departure delay.

Schedule buffering is not free. It is a fixed cost (as it applies to all planned flights) to the airline, considered to be only half of the uncertain (as it only applies to those flights that actually generated an delay) tactical delay costs which are estimated at 100€ per minute of delay in total.

When tactical costs (costs incurred on the day of the flight) increase faster than the schedule buffering costs, and are frequent, it becomes more cost-effective for an airline to apply schedule buffers.

In the most-likely Eurocontrol traffic forecast a typical summer day in 2040 will have 16 airports as congested as London Heathrow airport is now. That will push total all-causes network delays to an average of 20 minutes per flight up from 14.7 minutes per flight in 2018. It will be a challenge to provide an adequate quality of service, day in, day out in these circumstances. With so many airports expected to operate close to their capacity the use of schedule buffers will increasingly become important, and expensive, for airlines in order to maintain an acceptable level of arrival punctuality.

At peak demand times of the day (morning and evening) many other airports will also see an imbalance between the airline demand and the airport capacity (called capacity gap). Increased schedule buffering may cause more aircraft to flight plan to arrive ahead of schedule and feed the need for tactical ATFM measures to manage the shifting demand driving the need for additional ATFM regulations.

Fully integrating the airports in the Network (already during the planning phase) is therefore essential. See Recommendation 2 in the Report of the Wise Persons Group on the future of the Single European Sky on linking the Network Operations Plan and the Airport Operations Plan.

"Fully integrating the airports in the Network is essential"

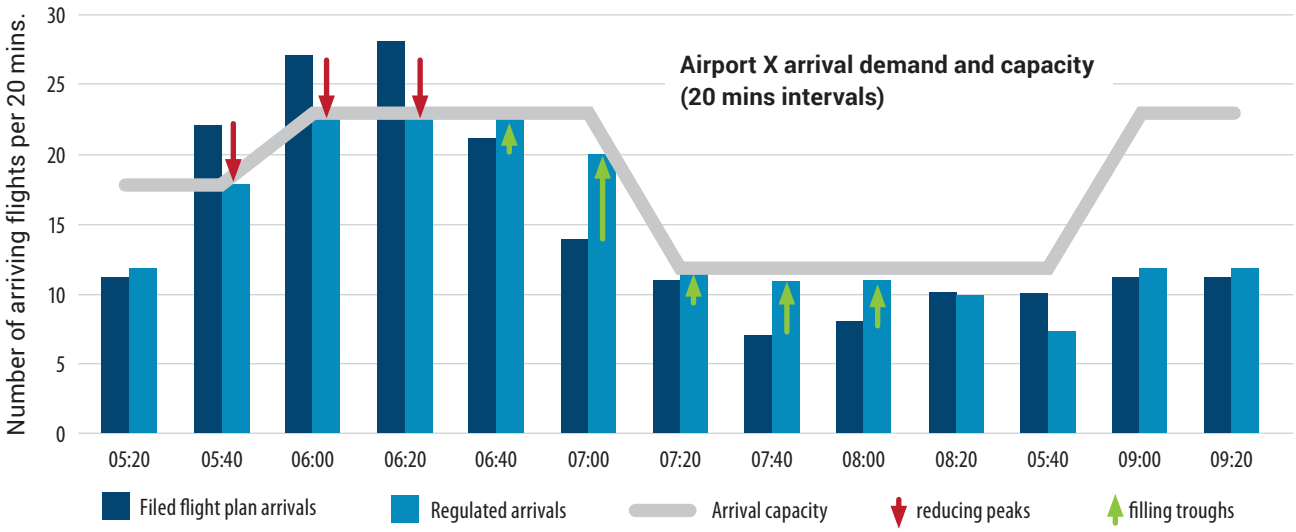
Smoothing demand

We use the arrival traffic at an (anonymised) airport to illustrate the smoothing effect of ATFM regulations.

Airport X is a hub airport with important variations in the traffic demand flows during the day, a 'wave' of inbound flights is followed by an outbound 'wave' creating a cycle of peaks and troughs in arrival demand. In order to accommodate these traffic peaks the airport capacity focus is altered between departure and arrival capacity.

On this day we observe that the actual arrival demand, based on the flight plan information, creates a peak and exceeds the arrival capacity of the airport between 05:40 and 06:40. This peak is often driven by the use of schedule buffers. On the other hand, between 07:40 and 09:00 we observe that the flight plan arrival demand is well below the arrival capacity creating a trough.

An ATFM arrival regulation is activated to smooth the arrival demand peak and align the demand with the arrival capacity ensuring safe operations and in many cases avoid additional air holding. By pushing the arrival demand in time it also filled most of the trough (difference between the capacity and flight planned demand) that was observed between 06:40 and 08:40. The result is a more efficient use of the available capacity across the day.



ATFM regulation vs arrival delay

Using the example given at the beginning we observe that more than a third of flights with an ATFM regulation of up to 20 minutes still arrive on time (ie less than 5 minutes delay) at their destination. This suggests that part of the ATFM regulations not only had a smoothing effect for air traffic control but also for the airline by pushing the flight closer to the scheduled arrival time.

2018 Network ATFM regulation minutes	Share of flights affected by ATFM regulation	Share of ATFM regulation minutes absorbed in airline schedule
between 05-15mins	5.5%	40%
between 16-30mins	3.5%	27%
between 31-60mins	1.7%	15%
> 60mins	0.4%	10%

The figure illustrates that, in 2018, 89% of flights in the Network were not regulated or did not generate additional ATFM regulation delay minutes. However 11% of flights did experience an ATFM regulation of more than 5minutes; these split between 5.5% of flights experiencing an ATFM regulation between 5 & 15 minutes and 5.5% of flights suffering an ATFM regulation exceeding 15 minutes.

Looking at the impact of these ATFM regulations on the arrival delay we observe significant differences. These cases are often more complex than the simple example we started with, and we therefore find it easier to compare in terms, not of fraction of flights delayed, but in minutes of regulation. Typically airlines can absorb a high share (if not all) of short ATFM regulations in their schedule. For 2018 we observe that 40% of ATFM regulations between 05 & 15 minutes were absorbed. However this reduces to 10% for ATFM regulations exceeding 60 minutes.

In Europe around 25% of ATFM regulation minutes were absorbed in the airline schedule and did not generate additional arrival delay at the destination airport and in many cases pushed a flight to arrive on-time rather than ahead of schedule.

"ATFM Regulations (slots) are a sign that there is not enough capacity in the aviation network"

2018 Network share of flights affected by an ATFM regulation

Conclusion

ATFM regulations are a sign that there is not enough capacity in the aviation network. But they are also an indication that the EUROCONTROL Network Manager's flow management system is working: primarily ensuring that an air traffic controller somewhere along your flight path doesn't suddenly have too many aircraft to deal with; smoothing out the peaks and troughs in demand.

We have explained how, for the lucky minority, regulations achieve this without delaying the passenger's arrival. In Europe around 25% of ATFM regulation minutes were accommodated in the airline schedule. Short ATFM regulations are more easily absorbed than longer ones.

ATFM regulations ensure a safe and smooth operation for air traffic control and are often a power for good by pushing a flight closer to the scheduled arrival time.

For the majority of passengers, however, ATFM delays continue to be very high in 2019. Capacity remains short, so there is no prospect that airlines, airports or air traffic managers, coordinated by the EUROCONTROL Network Manager, will be able to relax their continuing efforts to make the best of the limited capacity available.

"Capacity remains short due to a shortage of ATC capacity, airport capacity issues, scheduling, demand cycles and timings. It's a jigsaw!"

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