Tower Efficiency

Optimizing the departure sequence

A crucial point where many valuable seconds may be wasted, is the take-off sequence. Especially when there are a lot of traffic and narrow gaps, it is important to get the traffic into the air as quickly as possible.

Try to get as close as possible to the minimum separation between departing aircraft to avoid creating unnecessarily large gaps. If you wait just one minute too long, for example, you have reduced the airport's departure capacity of up to 50%. In order to enable efficient spacing, it may also be necessary to adjust the departure sequence so aircraft do not take off in the order in which they called the tower. At many airports, various intersections can be used for this purpose. Gaps on the frequency can be used for conditional line-up clearances.

It may make sense to deviate from the "first come, first served" principle for the following reasons:

Wake turbulence separation

In the picture we have the following constellation: A heavy is taxiing to the runway at the front, followed by another heavy and a medium at the end. If the planes now take off in this order, you need 4 NM between the first two heavies and 5 NM between the second heavy and the medium. This makes a total of 9 NM.

However, if we now prefer the medium and let it take off from intersection L4 as number 1, for example, we only need 3 NM between the medium and the first heavy and 4 NM between the two

heavies again. This makes a total of 7 NM. This means we have saved 2 NM directly - that's just under a minute.

Conclusion: If the medium and heavy arrive at the runway at relatively the same time, you should try to give preference to the medium in order to generate the lowest average delay. You should act sensibly though and not let a heavy wait for several minutes just to get a few mediums out first.

Mixing different SIDs

As you learned in the tower separation article, you usually need 5 NM of separation between aircraft on the same SIDs. With different SIDs, 3 NM radar separation is sufficient.

Suppose you have a situation in which, for example, two aircraft with the same SID are taxiing north to the runway and behind them an aircraft with a different SID is taxiing south to the runway. If you now give takeoff in this order, you need 5 NM between the same SID departures and 3 NM between the north and south SIDs.This means a total distance of 8 NM. However, if you now place the aircraft with the south SID between the two north SID departures, you only have to wait 3 NM in each case, which results in a total distance of 6 NM. This means that one aircraft has to wait a little longer, but another can get out much faster and you have saved an average of 2 NM and therefore also time.

Starke Performance-Unterschiede

Assuming you have a C172 IFR waiting at an intersection and a Boeing 777 at the beginning of the runway. You learned above that you should try to avoid wake turbulence. So do you now pull the C172 in front of the B777? If you did this, the B777 could of course take off 3 NM behind the C172, as we only need the radar separation. But in this case, the performance differences are so great that the B777 will have caught up with the C172 within a few seconds, both in terms of speed and altitude. This means that, despite the initial separation, the aircraft quickly will produce a loss of separation. In such a constellation, depending on when the flight paths of the C172 and B777 separate, it might take several minutes until the C172 has left the area the B777 will initially climb into or is 3 NM away from the SID of the B777, ensuring separation.

In such a case, it makes more sense to let the B777 take off first and have the C172 follow with 6 NM wake turbulence separation.

The constellation of the aircraft strongly influences when the performance differences outweigh the wake turbulence separation. In general, it can be said that all jet airliners have a similar performance, at least in terms of speed in climb, whereas props are often significantly slower. However, this does not always apply. If in doubt, it is better to wait a little too long than too short.

Avoid missed approaches

If there is a risk of loss of separation, the controller must take action. In addition to the option of a go around, the possible alternatives should also be considered. At international airports

(EDDx), for example, speed instructions can be given to avoid loss of separation.

However, if there is another aircraft behind the approach controller, this must be coordinated in advance. Reduced runway separation can also be used in appropriate conditions.

Handling close situations

A few questions that most tower controllers have certainly asked themselves at some point, including some food for thought (using the example of a 4 km long runway):

When is the last moment I can clear an aircraft for takeoff while an inbound is approaching?

Let's assume that the departing aircraft is already on the runway. A statement in the form of "the takeoff clearance must be given at X NM final at the latest" is difficult, because it essentially depends on two factors:

1. The speed of the inbound in the last part of the final approach (a slow aircraft still takes considerably longer to cross the runway threshold in the 3 NM final than a fast aircraft)
2. The inertia and speed of the outbound (it will take Boeing 747 a few seconds longer from take-off clearance until it actually starts rolling than a CRJ9, for example)

As a rule of thumb, most airliners need approx. 1:05 - 1:15 minutes from the start of the take-off run to flying over the end of the runway on a 4 km long runway. This means that the inbound aircraft should take a little more than 1 minute until crossing the runway threshold to ensure normal runway separation. Reduced runway separation (2,400 m), as may be used in good weather and with appropriate markings, is usually achieved after approx. 45 seconds.

If you now take into account the time between issuing the takeoff clearance and the start of the takeoff run (approx. 3 - 10 seconds), this means that the takeoff clearance for normal runway separation should be given when the inbound still needs a little more than a minute to reach the runway threshold (based on a 4 km runway; for a 3 km runway, you can deduct another approx. 10 seconds). For reduced runway separation (2,400m), it is also sufficient if the inbound will take just under a minute - but this will produce a close spacing, as in the picture below, and it is all the more important to make sure that the outbound actually rolls off.

But how do I know how long the inbound needs from its current position to the runway threshold? There are two possibilities:

1. Calculate: An inbound flying exactly 120 knots GS flies 120 NM / hour, i.e. 2 NM per minute. In other words, it still needs one minute in the 2 NM final. An inbound that flies 150 knots GS flies 150 NM / hour, i.e. 2.5 NM per minute. In other words, he still needs one minute in the 2.5 NM final. Everything in between must then be roughly interpolated in your head based on these calculations

2. Set the speed vector to one minute (in Euroscope via the top toolbar): When the minute vector meets the runway threshold, it will be exactly one minute until the inbound crosses it. The take-off run should have already been started a few seconds earlier for normal runway separation; otherwise you will "only" achieve reduced runway separation.
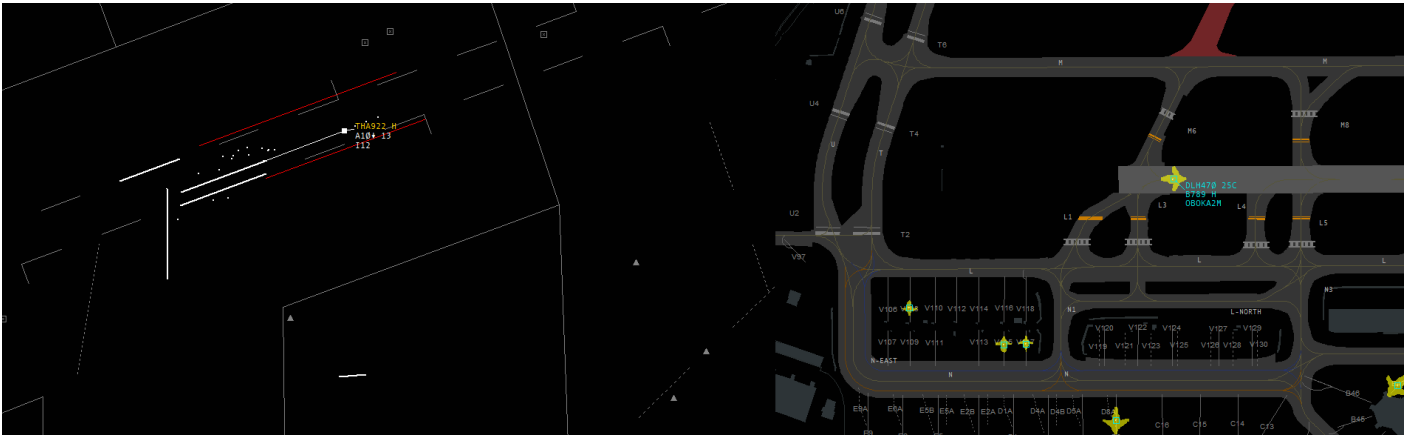
According to the speed vector, THA922 still needs 1 minute to reach the runway threshold, i.e. DLH470 must begin its take-off run in the next few seconds so we can maintain reduced runway separation. Normal runway separation is no longer possible, however, as the Thai would still have to be more than 1 minute away.

Result: With a buffer of a few hundred meters, we have reduced runway separation (the 2,400m marker is at L14)

What if the plane is still at the holding point?

The time for the lineup must be added to the minimum times mentioned above. This depends very much on the type of intersection (90-degree intersection vs. high-speed turnoff intersection like in EDDM) and also on the type of aircraft. A B748 lines up way more slowly than a small A320. Take a look at the typical lineup times for your airport. In the worst case (sluggish aircraft, 90-degree intersection) this can take around 60 seconds, in the best case (agile aircraft, angled intersection) sporty pilots are in the line-up position after just 20 seconds. The average is somewhere in between. As a result, you can average that if the inbound is still about 2 minutes away from the runway threshold, you can give line-up and takeoff clearance from the holding point if you motivate the pilot accordingly (see below) and usually get normal runway separation. Here, too, you can either calculate or display the 2-minute speed vector to know where the inbound will be 2 minutes out.

How much separation do I need between two inbounds to get an outbound between them?

In addition to all the factors mentioned above, there is another factor to consider: the availability and type of runway exits. In such a constellation, the factor limiting the outbound takeoff clearance is usually that the first inbound has to get off the runway first. At airports such as Munich or Frankfurt with many available high-speed turnoffs, under good conditions the time between flying over the runway threshold and leaving the runway is around 45 seconds. Heavy aircraft need slightly longer than 60 seconds. On Vatsim, there is also the factor of pilot quality - if you cannot assess the pilot exactly, you should calculate rather conservatively and assume a runway occupancy time of 1 - 1.5 minutes.

During this time, the outbound pilot will usually already have completed the lineup and can be cleared for take-off. The same rough values apply as explained above.

If you now add the two values - runway occupancy time of the first inbound + time from takeoff to flying over the runway threshold of the outbound, you arrive at around 2 minutes (ambitious) to 2.5 minutes (conservative). This means that the second inbound should still be 2 - 2.5 minutes away from the runway threshold when the front inbound is over the runway threshold. Depending on the wind and aircraft type, this means a **gap of around 5 - 6 NM at touchdown**. Most airport SOPs will therefore recommend take-offs and landings on the same runway to create 6-mile gaps between the inbounds to get outbound between. Now you also know the theoretical background to this.

How can I increase my chances on the frequency that a close situation works out?

Luckily, there are a couple of phraseology tools which you may and should use for closer situations:

An inbound shall vacate the runway quickly?

> " "DLH4JA, after landing expedite vacating, wind 280 degres, 5 knots, runway 25C cleared to land"

An outbound shall be prepared to depart quickly?

> " "DLH3CN, prepare for immediate departure (as soon as runway is clear)"

Thereafter:

> " "DLH3CN, wind 280 degrees 5 knots, runway 25C, cleared for immediate takeoff"

There will be an outbound just before the inbound touches?

> " "CFG4MA, reduce to final approach speed, expect late clearance, traffic, A320 departing ahead"

- "Reduce to final approach speed" may only be used when there is no traffic behind which would affect separation. Otherwise, this has to be coordinated with the approach controller
- Giving the traffic information is beneficial because in case of Reduced Runway Separation, you have already given the traffic information before
- "Expect late clearance" makes sure that the pilot does not unnecessarily ask for the landing clearances e.g. on 2 NM final

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