

Capacity assessment of Dublin airport

Modelled impact of proposed S18 capacity changes

24 August 2017



Overall aims of the capacity study

Assessment of the capacity at Dublin Airport for the purpose of setting slot coordination parameters

The scope of the study is:

- Assessment of capacity of runways 10 and 28 under a range of parameters
- Evaluation of stand and apron capacity
- Identification of pinch points on the taxiway system
- Assessment of appropriate delay criteria
- Assessment of the maximum capacity when coordinating to a 10-minute period compared to a 5-minute period
- Assessment of capacity of terminals 1 and 2
- High-level assessment of airspace capacity, roads and parking lot capacity.

Purpose of this presentation

Evaluation of the impact of the proposed S18 capacity increases on:

- Departure taxi out time
- Departure taxi delay
- Runway holding delay
- Other delay (e.g. pulling, towing or pushback delay)
- Total departure ground delay
- Arrival taxi in time
- Arrival taxi delay
- Passenger waiting times at various processes inside the terminal building

Methodology

As a result of the feedback received both during the Coordination Committee pre-meeting held on 17 August 2017 and post-meeting, we have revised some elements of the methodology applied to assess impact of forecast S18 changes. The main change is a substantial increase to the number of flights in the schedule.

Due to these changes, all findings presented in this document should be considered to have fully superseded the previous results distributed prior the 17 August 2017.

The following slides detail the methodology applied.

Methodology

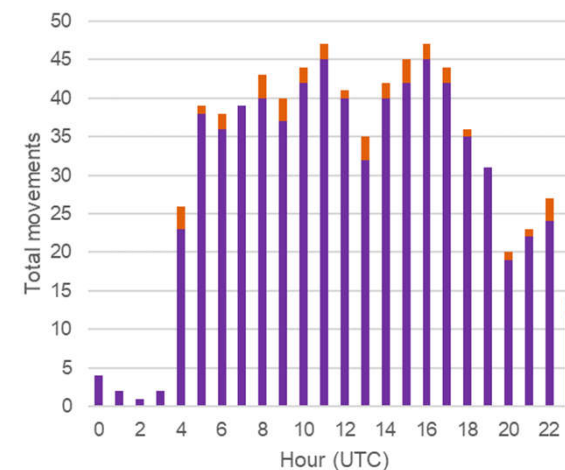
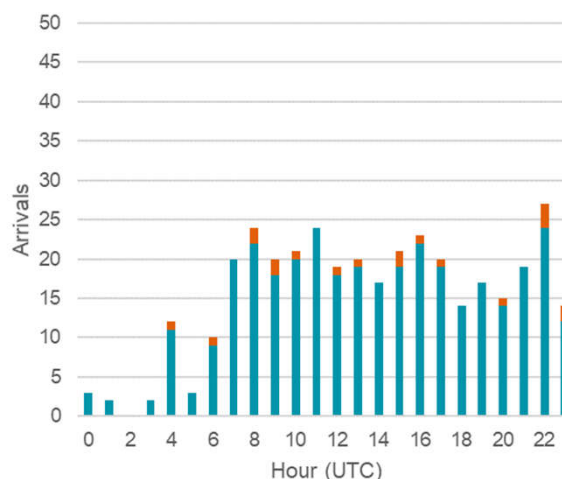
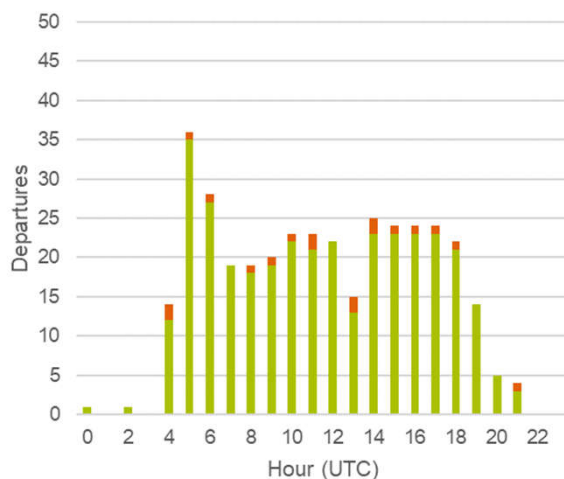
- Fast time simulation models have been developed and validated using data provided by daa, IAA and collected locally
 - **Airside simulations**
 - Simulation of runways, taxiways, stand allocation and limited towing
 - Validation demonstrated a close match between simulation and observed performance on a design day in Summer 2016.
 - **Terminal simulations**
 - Simulation of T1 and T2 processes for boarding pass scan, waiting times, US pre-clearance and immigration
 - Validation shows model is accurate in some areas but somewhat conservative in others when compared to a design day in Summer 2016.

Methodology

- Development of S16 design day (23 June 2016) model
- Review and validation of S16 model against actual performance
- Development of reference S17 model
 - S17 design day (11 August 2017) flight schedule
 - Infrastructure changes between S16 and S17
- Development of S18 model:
 - Flight schedule for the S18 model consists of the original S17 design day flight schedule increased by 36 services from the S18 forecast and one additional arrival in the 2200 UTC
 - S18 traffic profile has not been upscaled to hourly capacity declaration limits, but
 - In periods where S18 schedule exceeded declared capacity a minimum number of flights have been moved to adjacent hours

Methodology – simulated schedules

Hourly breakdown of flights modelled in S17 and S18 scenarios:



■ 2017 Design day departures ■ S18 forecast departures

■ 2017 Design day arrivals ■ S18 forecast arrivals

■ 2017 Design day movements ■ S18 forecast movements

Hour of Day (UTC)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	Total
2017 Design day arrivals	3	2	0	2	11	3	9	20	22	18	20	24	18	19	17	19	22	19	14	17	14	19	24	12	348
S18 forecast arrivals	0	0	0	0	+1	0	+1	0	+2	+2	+1	0	+1	+1	0	+2	+1	+1	0	0	+1	0	+3	+2	+19
S17 design day + S18 forecast	3	2	0	2	12	3	10	20	24	20	21	24	19	20	17	21	23	20	14	17	15	19	27	14	367
2017 Design day departures	1	0	1	0	12	35	27	19	18	19	22	21	22	13	23	23	23	23	21	14	5	3	0	0	345
S18 forecast departures	0	0	0	0	+2	+1	+1	0	+1	+1	+1	+2	0	+2	+2	+1	+1	+1	+1	0	0	+1	0	0	+18
S17 design day + S18 forecast	1	0	1	0	14	36	28	19	19	20	23	23	22	15	25	24	24	24	22	14	5	4	0	0	363
2017 Design day flights	4	2	1	2	23	38	36	39	40	37	42	45	40	32	40	42	45	42	35	31	19	22	24	12	693
S18 forecast movements	0	0	0	0	+3	+1	+2	0	+3	+3	+2	+2	+1	+3	+2	+3	+2	+2	+1	0	+1	+1	+3	+2	+37
S17 design day + S18 forecast	4	2	1	2	26	39	38	39	43	40	44	47	41	35	42	45	47	44	36	31	20	23	27	14	730

Airside modelling (Runway 28)

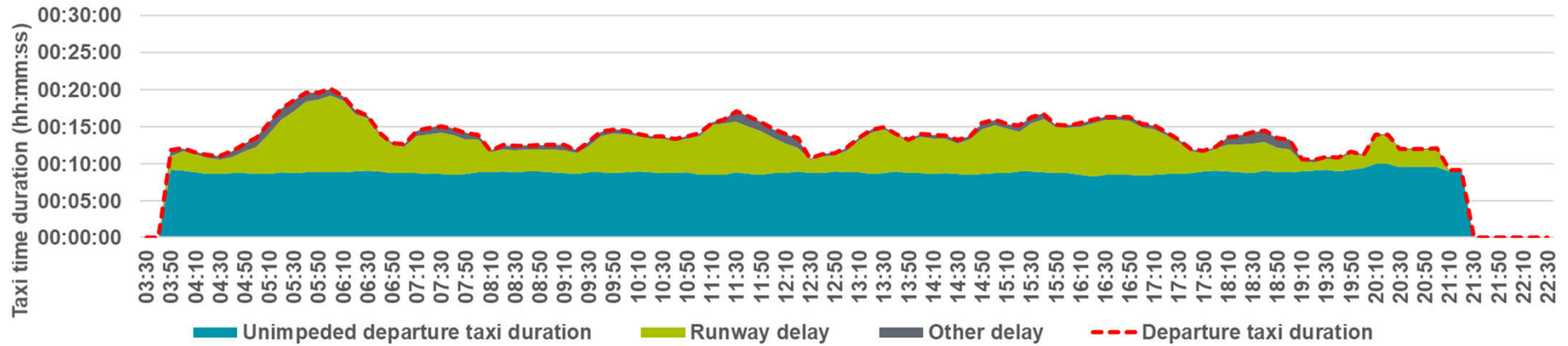


Runway 28

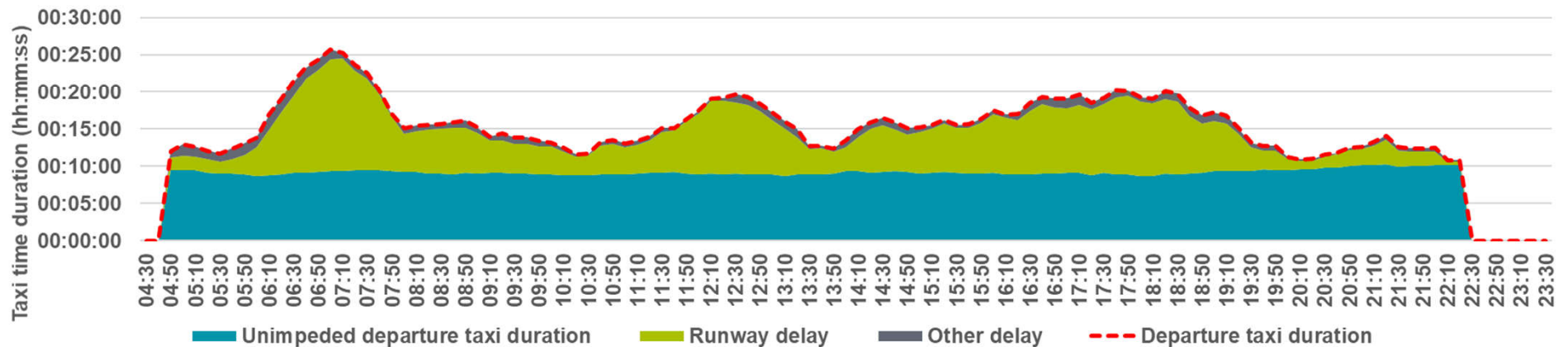
Departure taxi out time

*all times UTC

S17 Design day



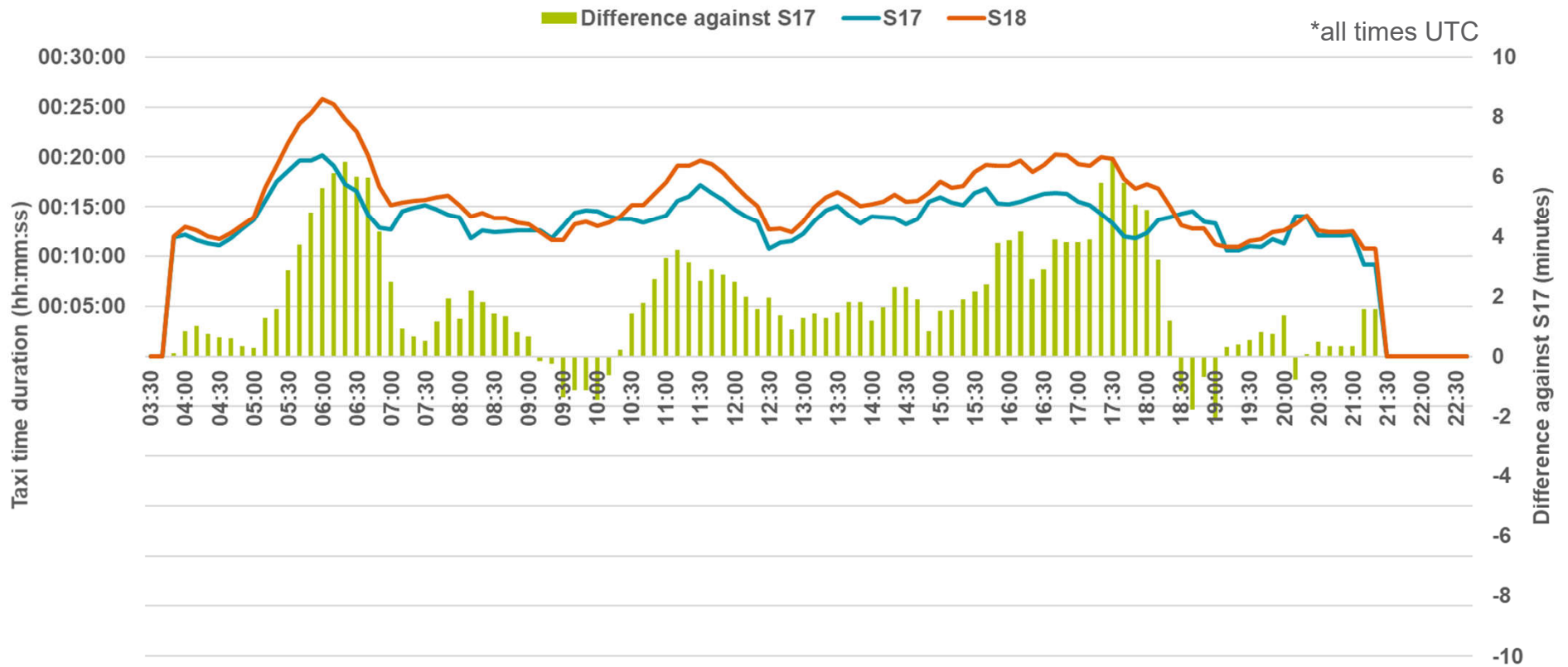
S18 Forecast



Runway 28

Departure taxi out time

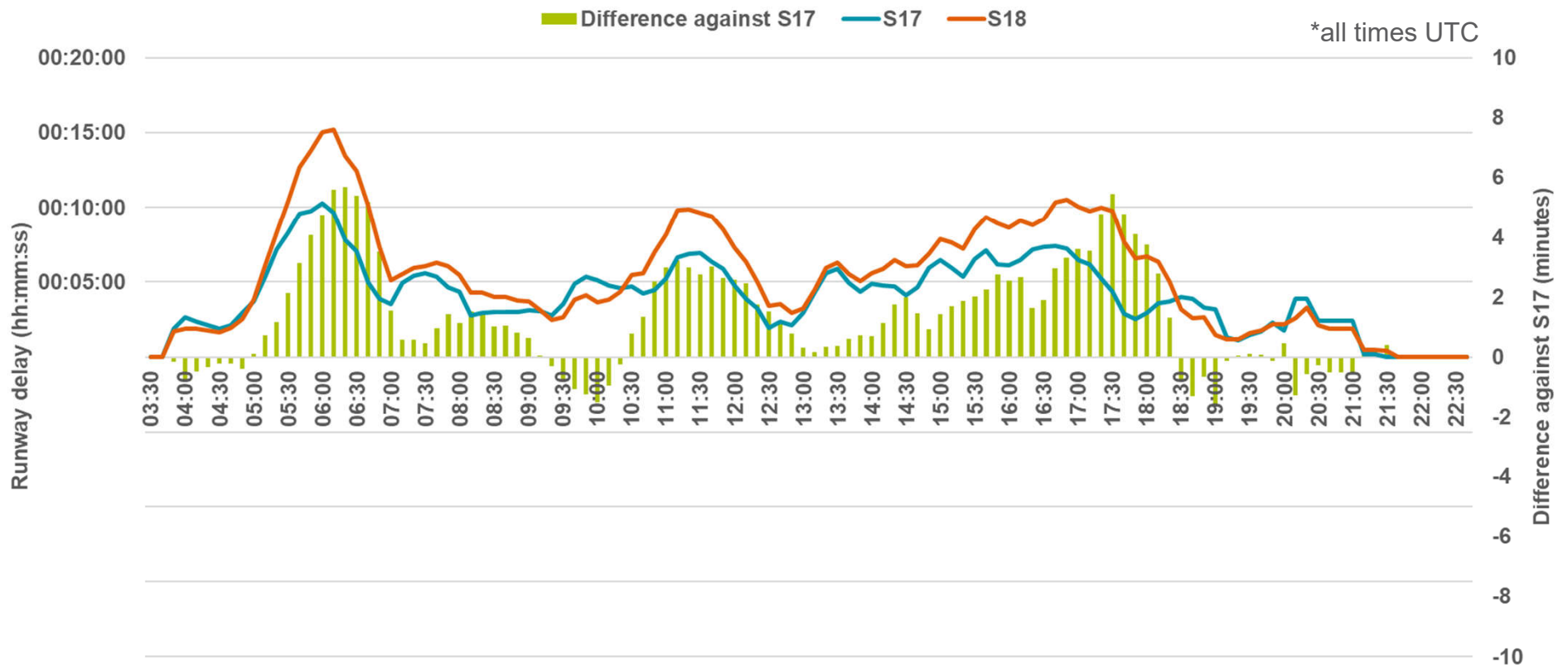
Definition: The time duration the aircraft has been taxiing for departure on the ground of its departure airport. This value is updated every second of simulation time when the aircraft is taxiing for departure even if the aircraft is stopped on ground. This metric is defined to be the time period between off-block and the time the aircraft reaches its stop bar for runway entry.



Runway 28

Runway holding delay

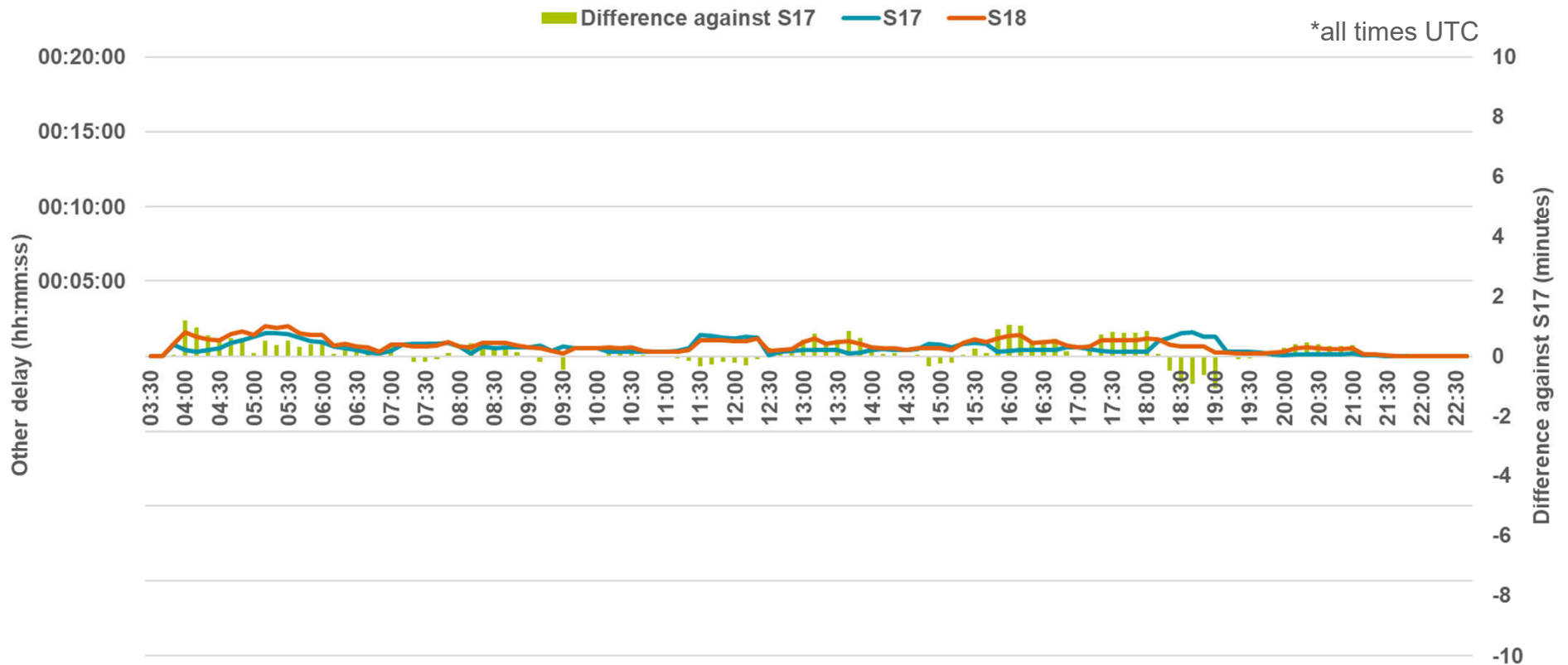
Definition: The delay experienced while the aircraft is queueing for runway entry. The delay can be caused by other aircraft (being slowed down or stopped) or when waiting at runway stop-bar (because the runway is not free for lining up). This metric is defined to be the time period between joining the back end of the queue and the time the aircraft reaches its stop bar for runway entry.



Runway 28

Other ground delays

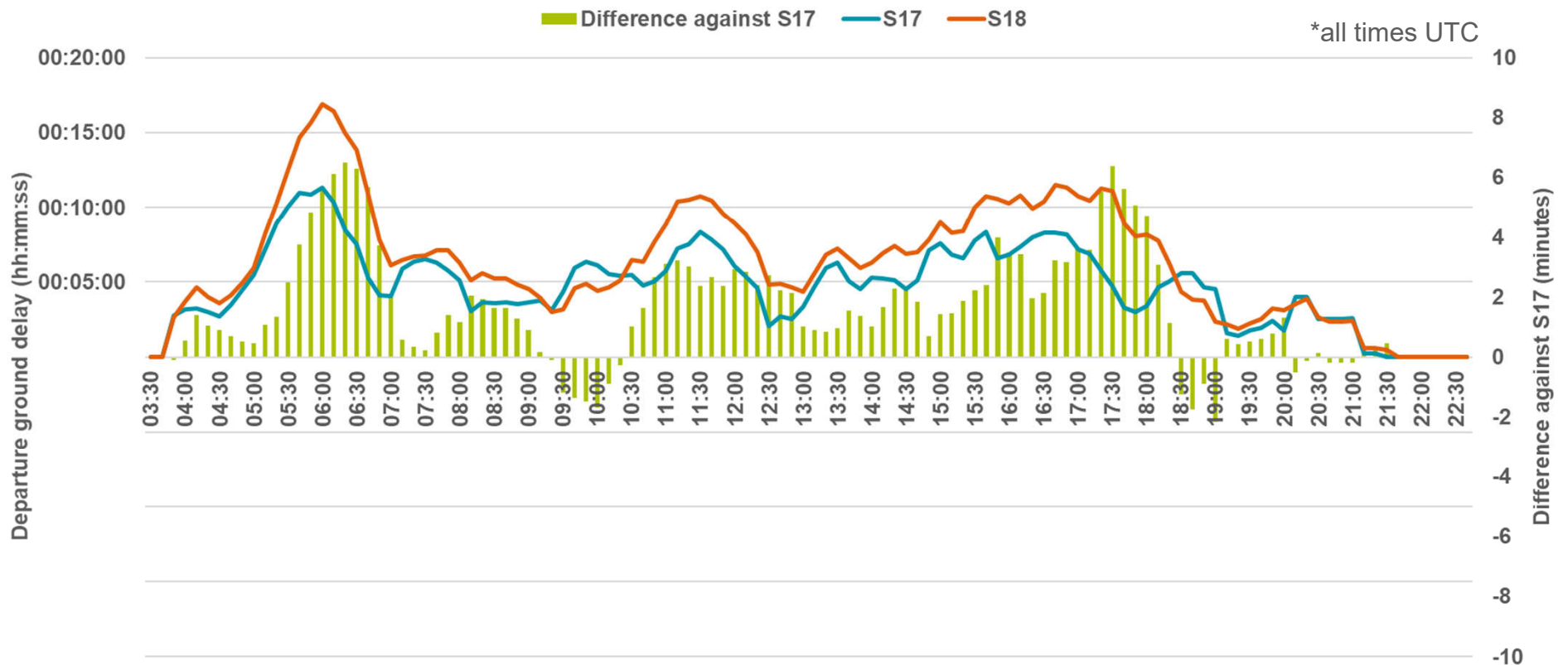
Definition: This metric includes combination of other delays (other than runway delay), for example delay due to crossing traffic, pulling delay, towing delay and pushback delay.



Runway 28

Departure ground delay

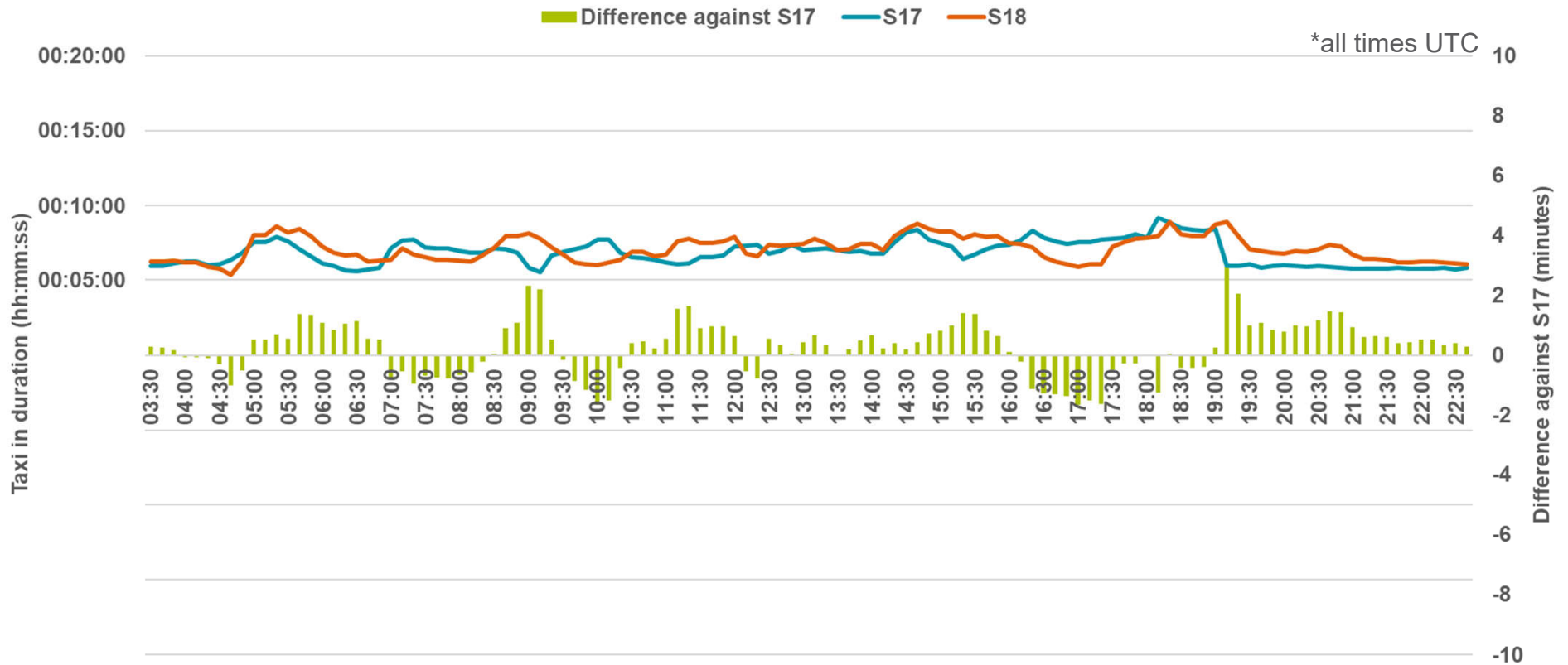
Definition: Total delay of departing aircraft accumulated between off-block and entering the runway. It is effectively the sum of runway holding delay and other delays.



Runway 28

Arrival taxi in time

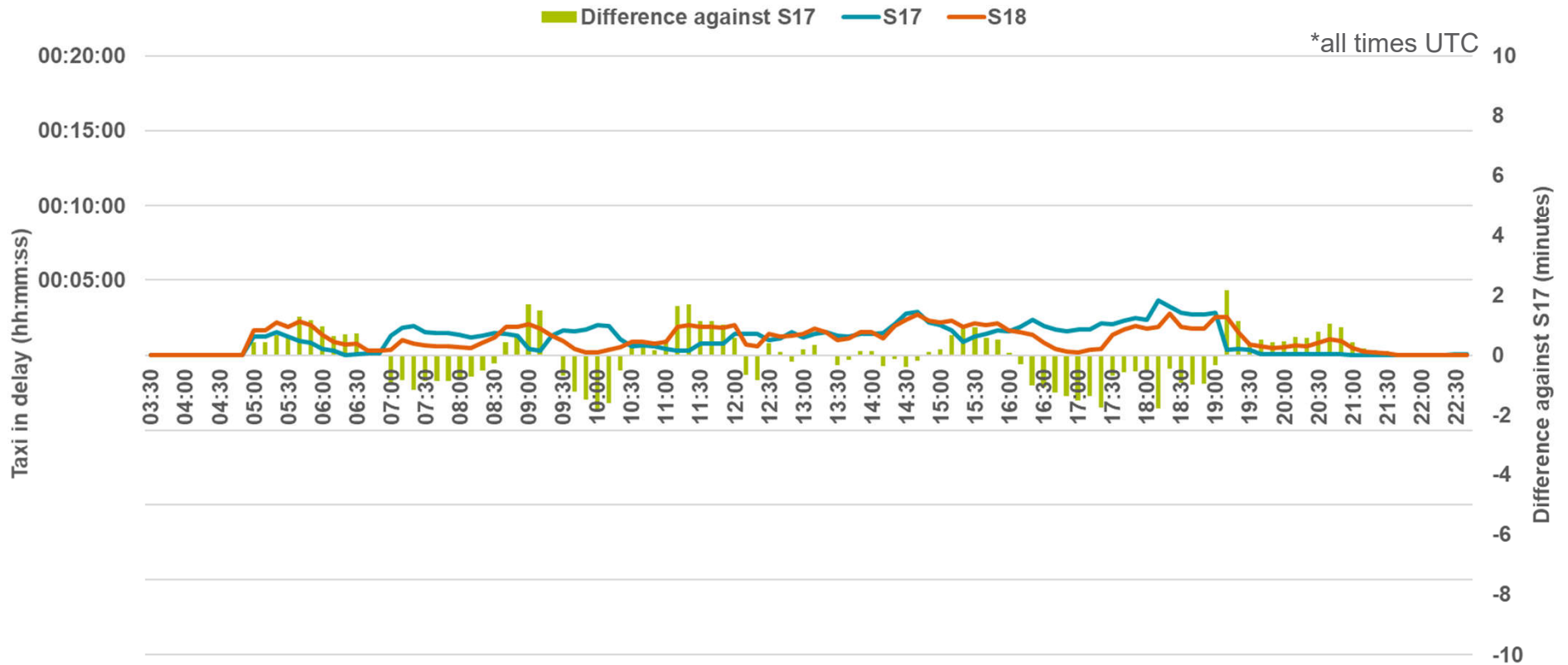
Definition: The time duration the arriving aircraft has been taxiing on the ground of its arrival airport. This value is updated every second of simulation time when the arriving aircraft is taxiing even if the aircraft is stopped on ground.



Runway 28

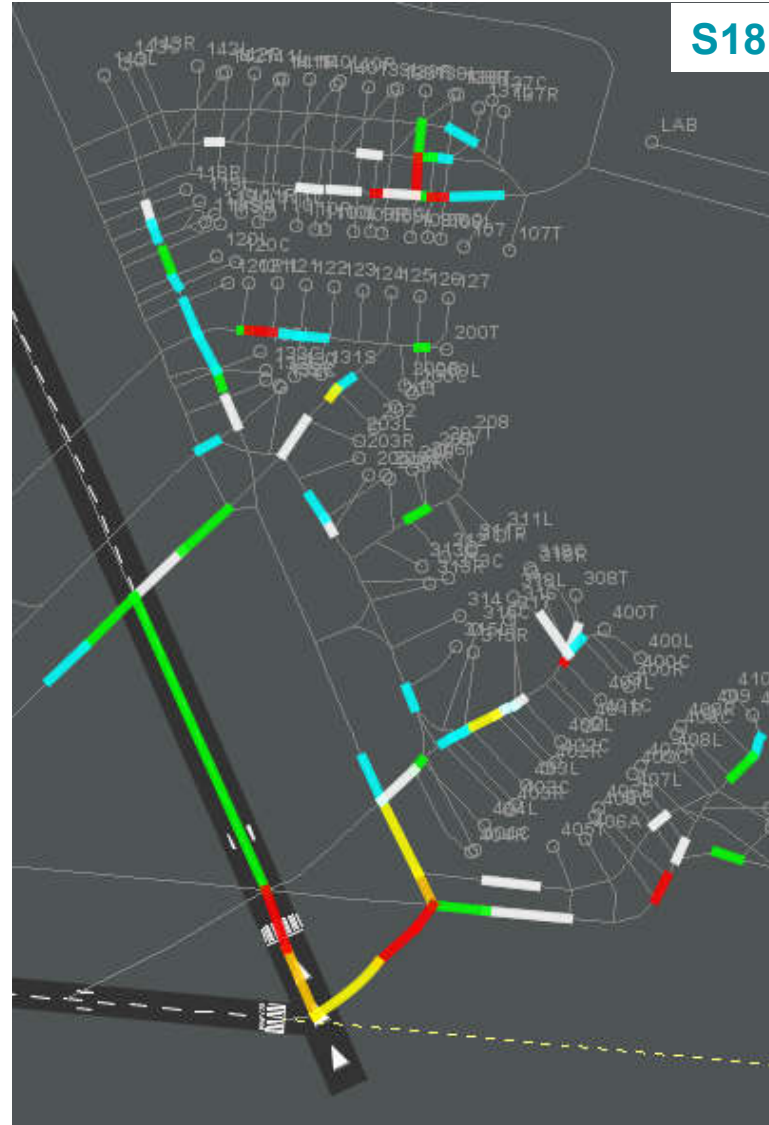
Arrival taxi delay

Definition: The delay caused by traffic (slowing down or being stopped) while the aircraft is taxiing to its arrival stand. Every second of simulation time the aircraft is stopped on ground due to other traffic, the delay is increased accordingly. Additionally, if the aircraft is forced to slow-down due to other traffic, a proportional delay is calculated.



Runway 28

Delay accumulated on taxiway segments throughout the day



Legend	
[White]	> 1 min
[Cyan]	> 2 min
[Green]	> 5 min
[Yellow]	> 10 min
[Orange]	> 15 min
[Red]	> 20 min

Runway 28

Taxi times by stand group

Average departure taxi time (off-block to stop bar)

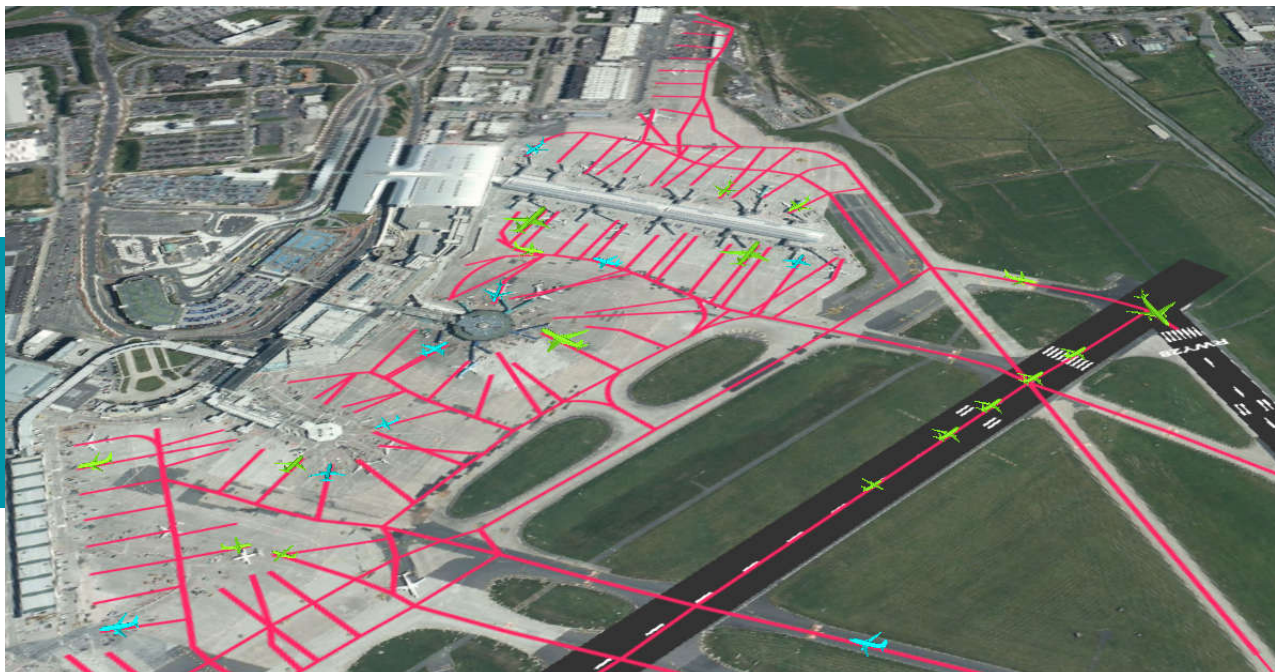
	S17 Design day	S18 forecast	Change (minutes)
5G	00:14:52	00:17:47	+2.9
P1N	00:13:20	00:15:49	+2.5
P1S	00:12:31	00:13:48	+1.3
P2N	00:13:31	00:13:16	-0.3
P2S	00:13:28	00:12:38	-0.8
P3N	00:11:06	00:14:25	+3.3
P3S	00:12:32	00:14:01	+1.5
P4N	00:12:11	00:15:47	+3.6
P4S	00:10:41	00:12:24	+1.7
SA	00:12:56	00:14:39	+1.7
Triangle	00:11:36	00:13:14	+1.6

Average departure taxi time (off-block to airborne)

	S17 Design day	S18 forecast	Change (minutes)
5G	00:16:45	00:19:52	+3.1
P1N	00:15:19	00:17:50	+2.5
P1S	00:14:29	00:15:49	+1.3
P2N	00:15:28	00:15:14	-0.2
P2S	00:15:30	00:14:39	-0.9
P3N	00:13:09	00:16:29	+3.3
P3S	00:14:35	00:15:59	+1.4
P4N	00:14:15	00:17:54	+3.6
P4S	00:12:44	00:14:31	+1.8
SA	00:14:57	00:16:31	+1.6
Triangle	00:13:23	00:14:59	+1.6

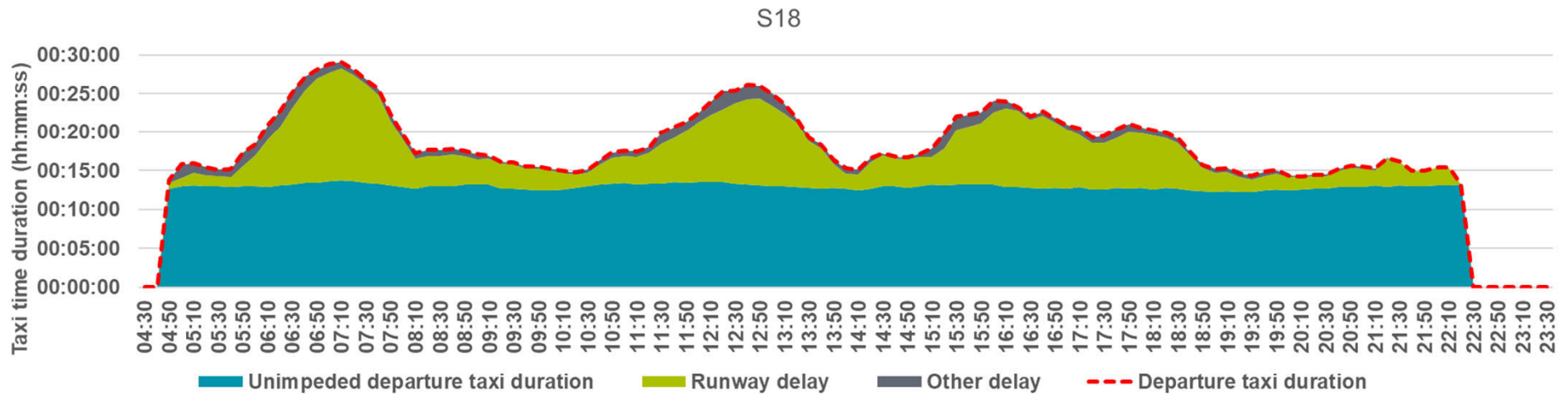
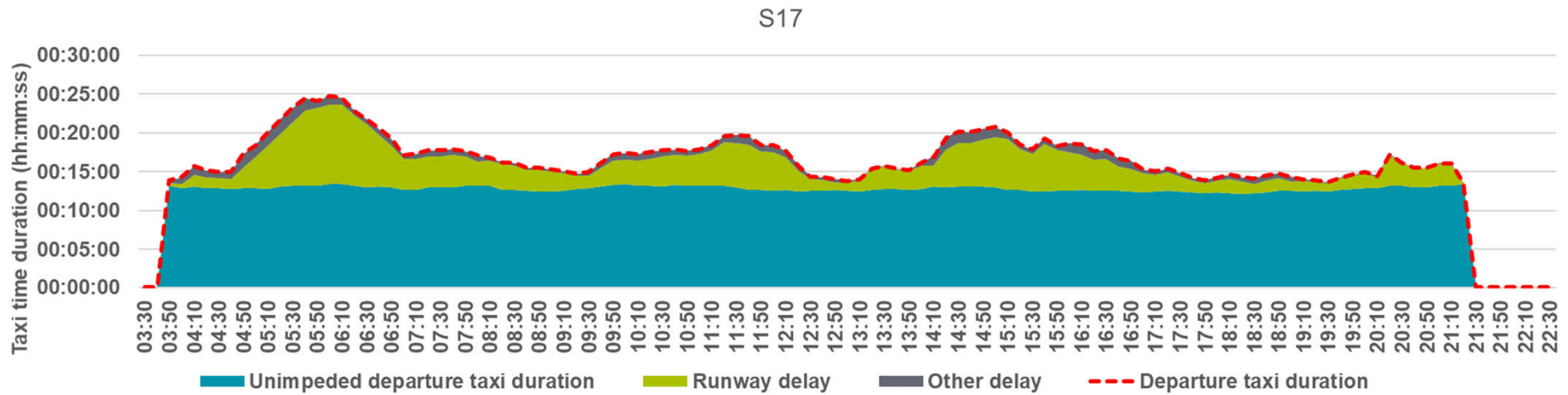
*Due to a small data sample the presented average taxi times are informative only.

Airside modelling (Runway 10)



Runway 10 Departure taxi out time

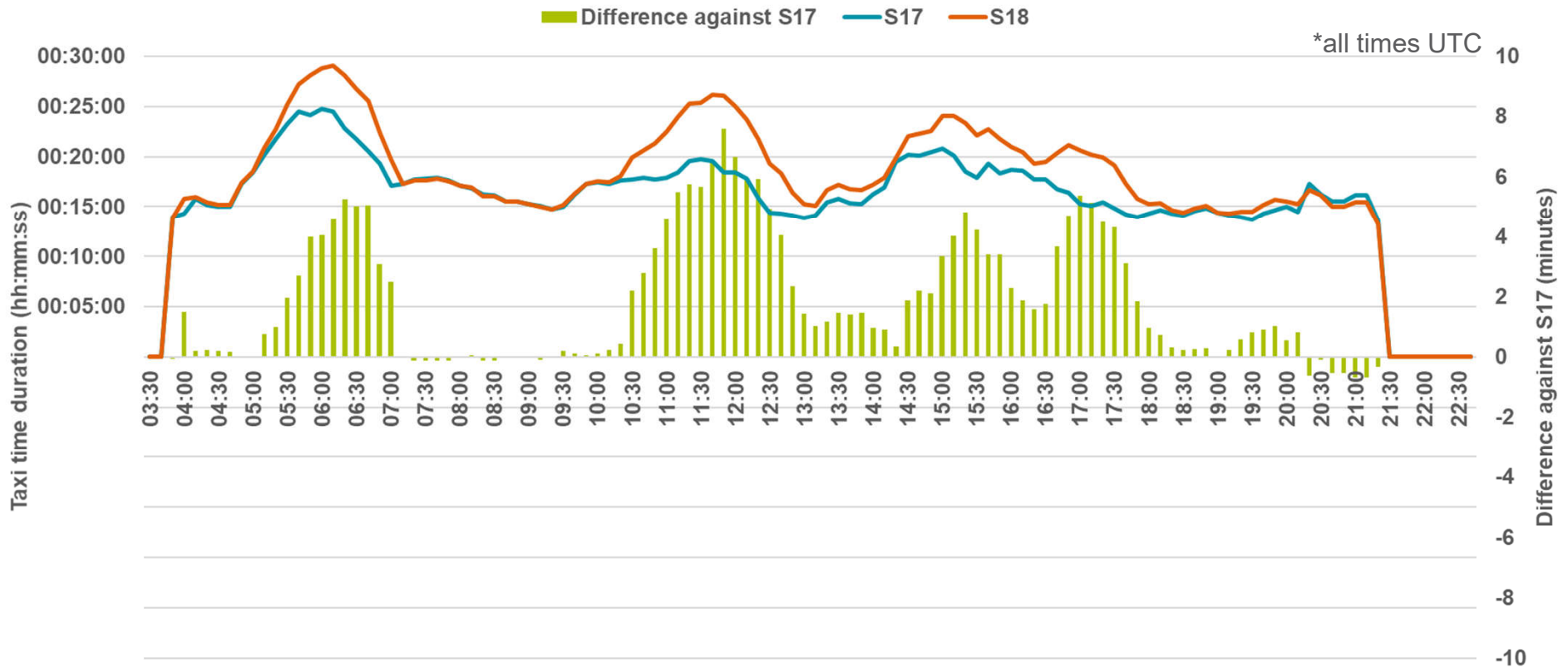
*all times UTC



Runway 10

Departure taxi out time

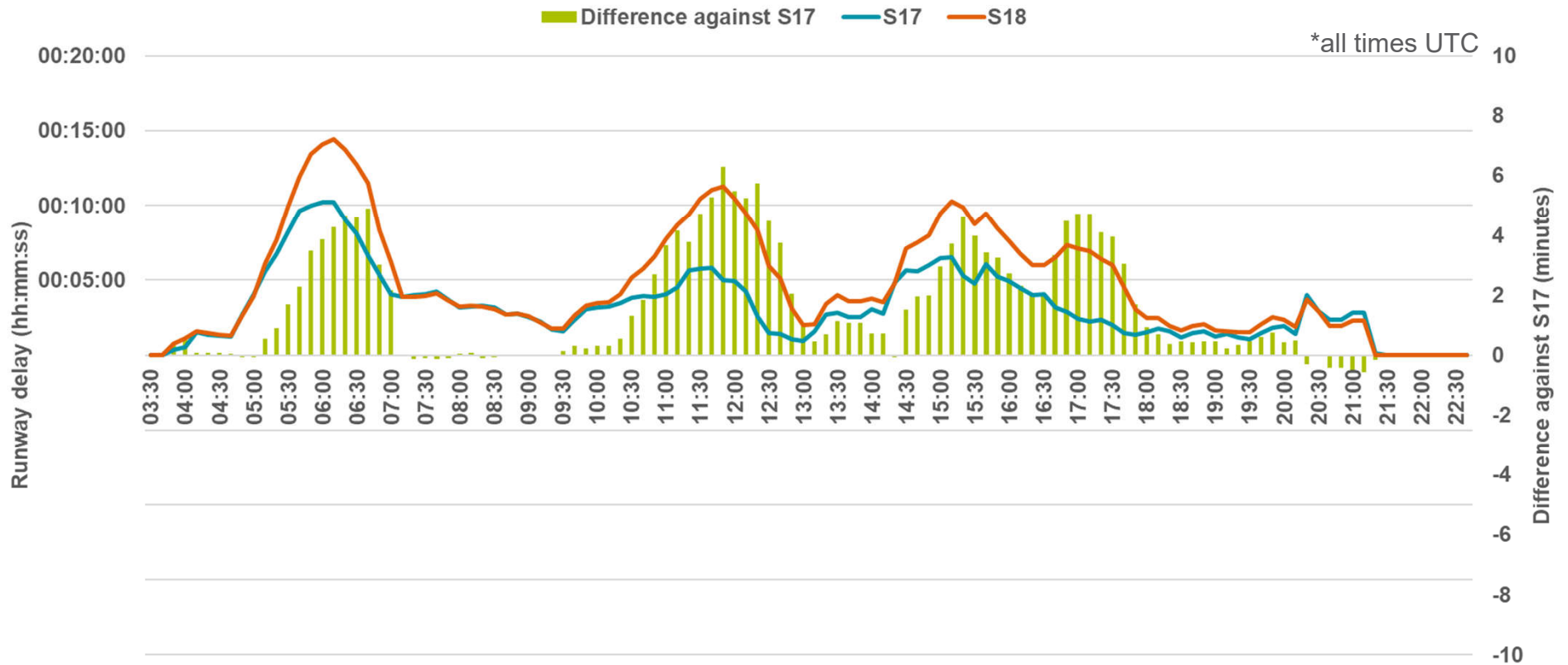
Definition: The time duration the aircraft has been taxiing for departure on the ground of its departure airport. This value is updated every second of simulation time when the aircraft is taxiing for departure even if the aircraft is stopped on ground. This metric is defined to be the time period between off-block and the time the aircraft reaches its stop bar for runway entry.



Runway 10

Runway holding delay

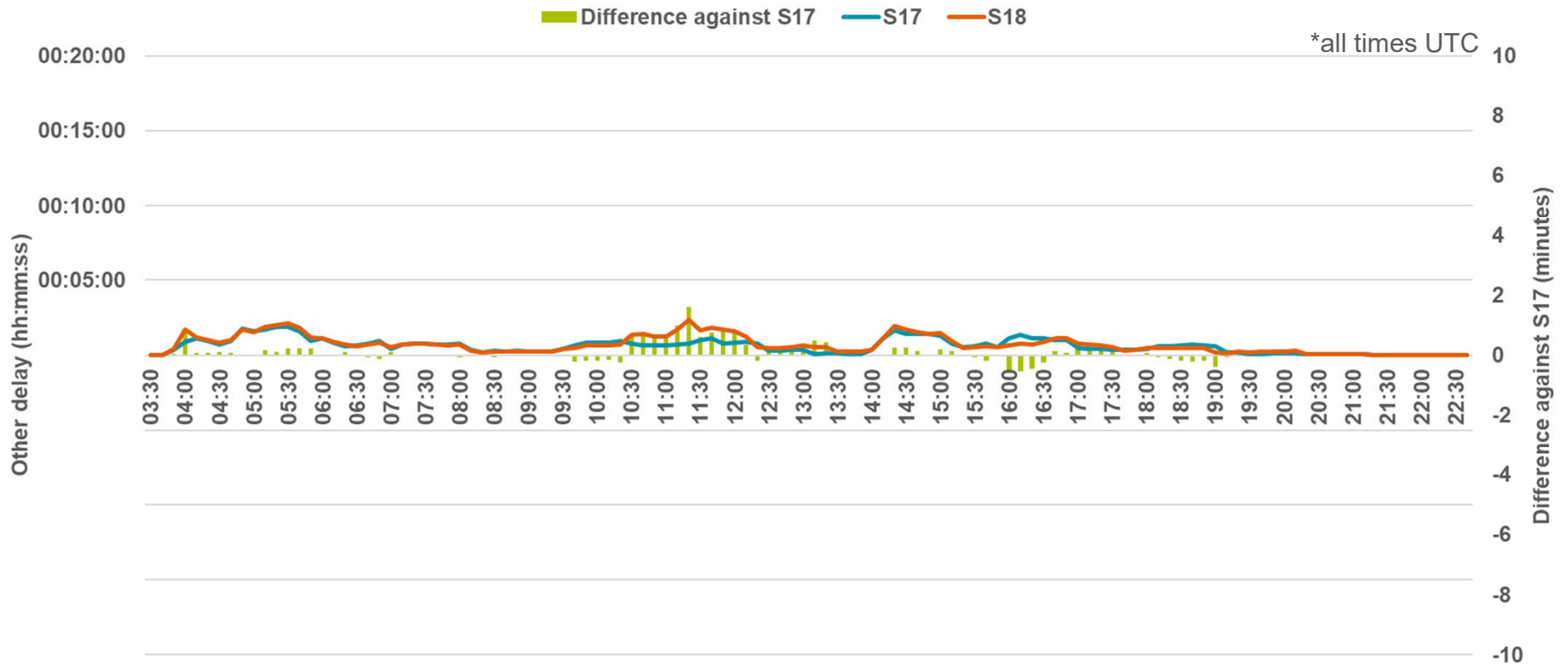
Definition: The delay experienced while the aircraft is queueing for runway entry. The delay can be caused by other aircraft (being slowed down or stopped) or when waiting at runway stop-bar (because the runway is not free for lining up). This metric is defined to be the time period between joining the back end of the queue and the time the aircraft reaches its stop bar for runway entry.



Runway 10

Other ground delays

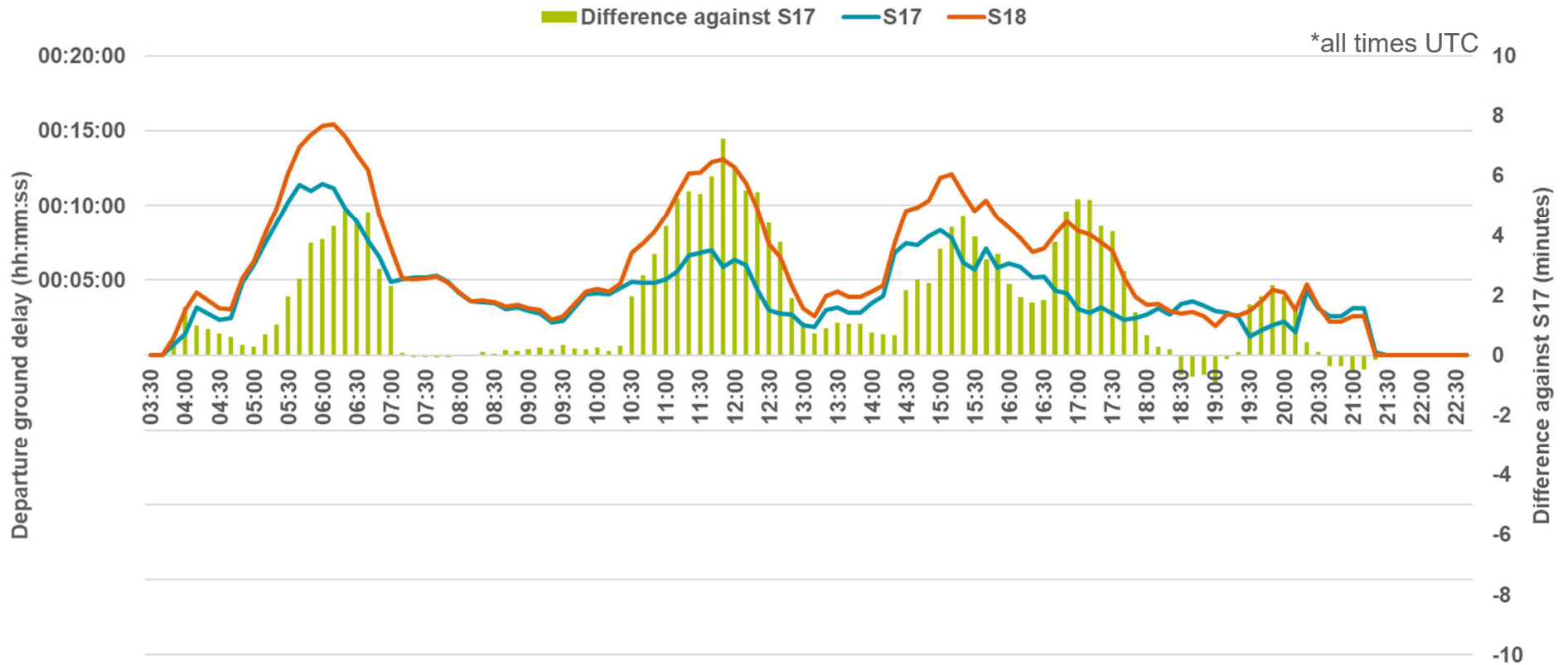
Definition: This metric includes combination of other delays (other than runway delay), for example delay due to crossing traffic, pulling delay, towing delay and pushback delay.



Runway 10

Departure ground delay

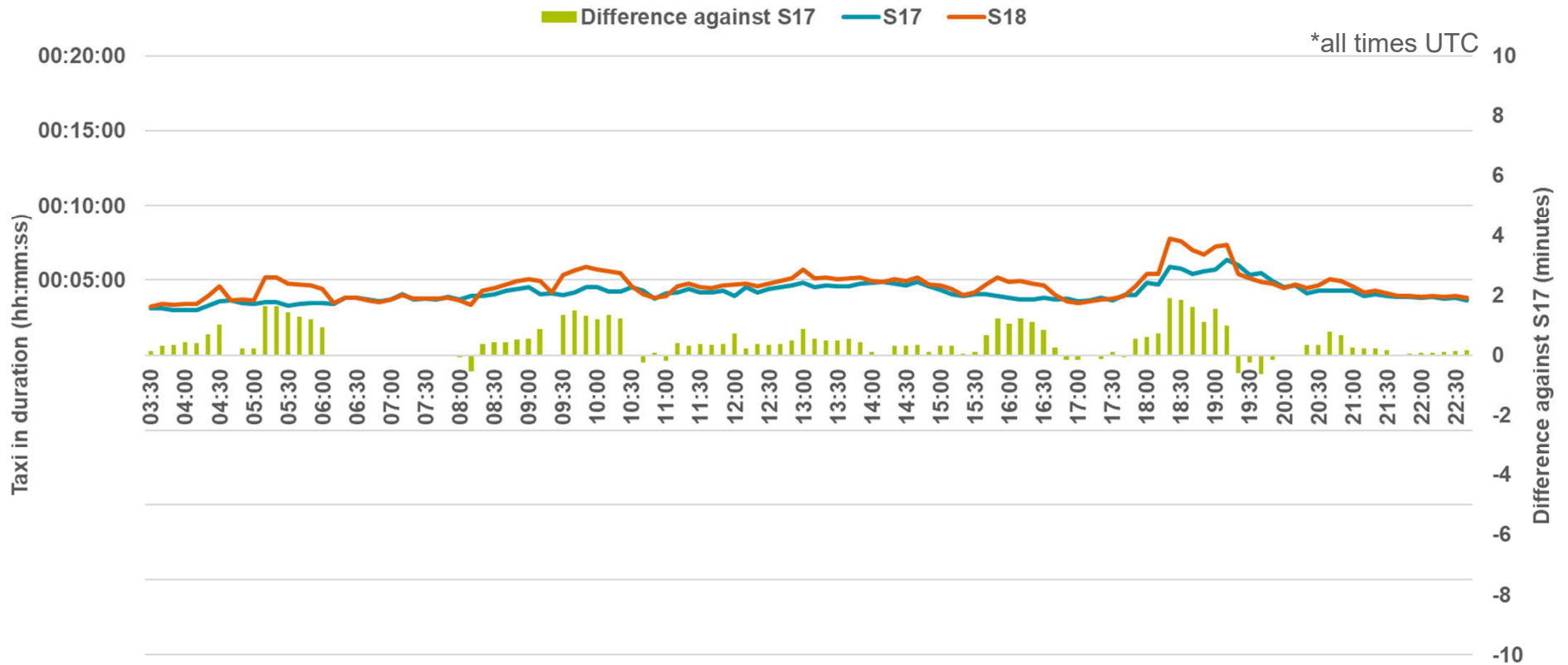
Definition: Total delay of departing aircraft accumulated between off-block and entering the runway. It is effectively the sum of runway holding delay and other delays.



Runway 10

Arrival taxi in time

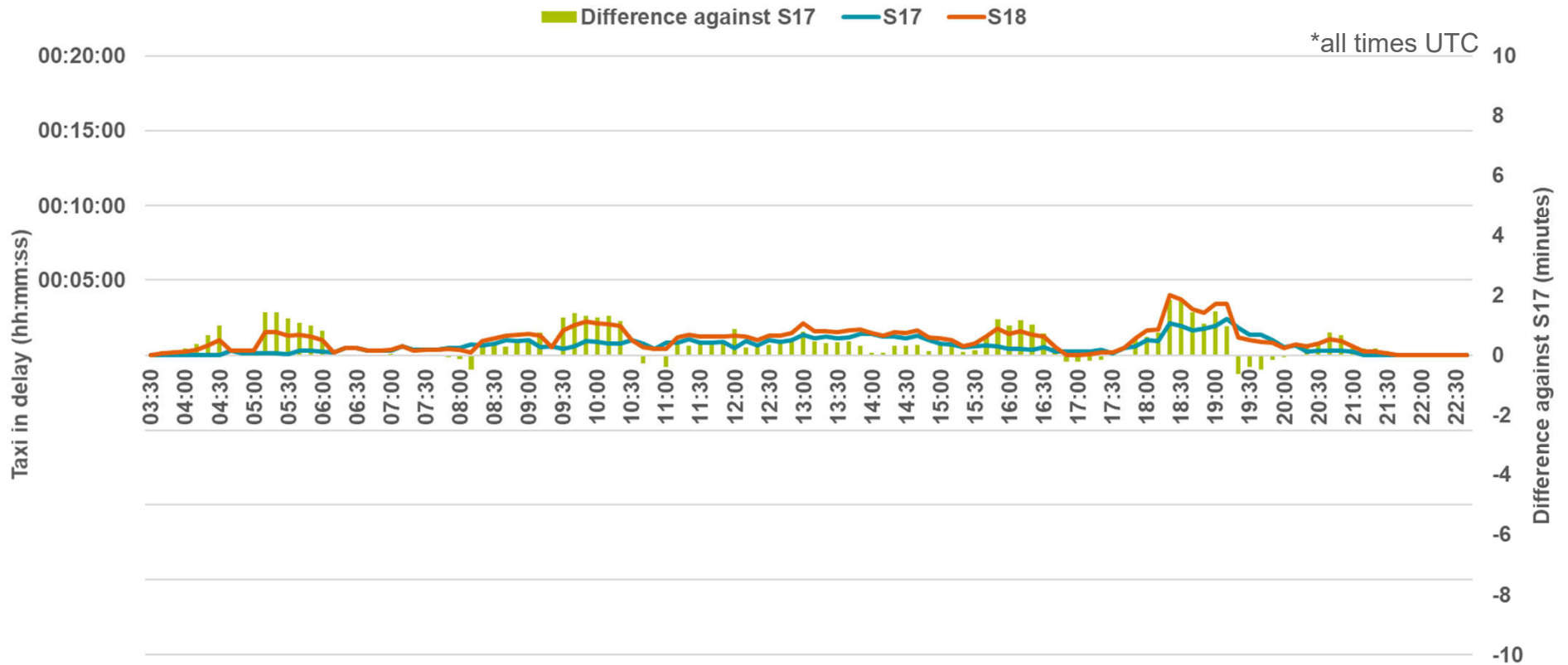
Definition: The time duration the arriving aircraft has been taxiing on the ground of its arrival airport. This value is updated every second of simulation time when the arriving aircraft is taxiing even if the aircraft is stopped on ground.



Runway 10

Arrival taxi delay

Definition: The delay caused by traffic (slowing down or being stopped) while the aircraft is taxiing to its arrival stand. Every second of simulation time the aircraft is stopped on ground due to other traffic, the delay is increased accordingly. Additionally, if the aircraft is forced to slow-down due to other traffic, a proportional delay is calculated.



Runway 10

Delay accumulated on taxiway segments throughout the day



Legend	
	> 1 min
	> 2 min
	> 5 min
	> 10 min
	> 15 min
	> 20 min



Runway 10

Taxi times by stand group

Average departure taxi time (off-block to stop-bar)

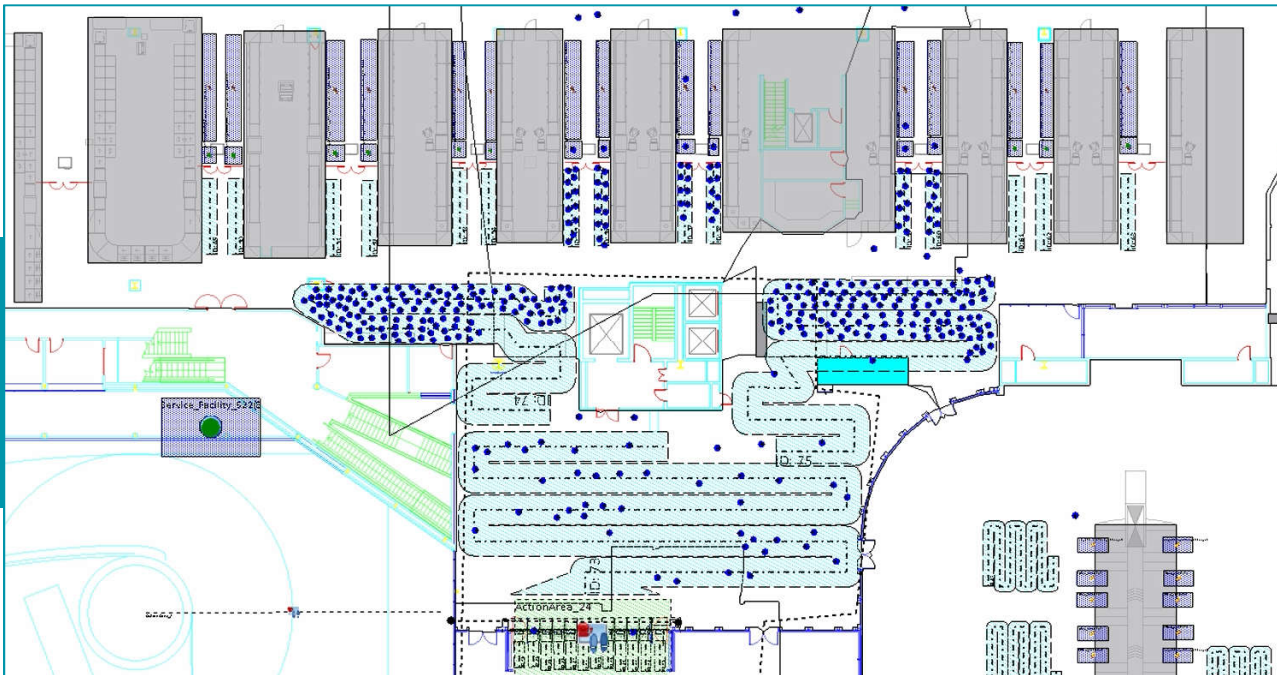
	S17 Design day	S18 forecast	Change (minutes)
5G	00:19:37	00:19:30	-0.1
P1N	00:15:43	00:17:38	+1.9
P1S	00:14:05	00:16:03	+2.0
P2N	00:14:16	00:18:02	+3.8
P2S	00:13:09	00:14:47	+1.6
P3N	00:15:35	00:18:39	+3.1
P3S	00:17:03	00:20:56	+3.9
P4N	00:17:56	00:20:19	+2.4
P4S	00:17:49	00:19:28	+1.6
SA	00:21:56	00:24:20	+2.4
Triangle	00:13:33	00:16:03	+2.5

Average departure taxi time (off-block to airborne)

	S17 Design day	S18 forecast	Change (minutes)
5G	00:21:34	00:21:16	-0.3
P1N	00:17:33	00:19:34	+2.0
P1S	00:15:55	00:17:54	+2.0
P2N	00:16:02	00:19:46	+3.7
P2S	00:15:04	00:16:41	+1.6
P3N	00:17:31	00:20:34	+3.0
P3S	00:19:08	00:23:00	+3.9
P4N	00:19:54	00:22:19	+2.4
P4S	00:19:42	00:21:24	+1.7
SA	00:24:05	00:26:26	+2.4
Triangle	00:15:09	00:17:47	+2.6

*Due to a small data sample the presented average taxi times are informative only.

Terminal modelling

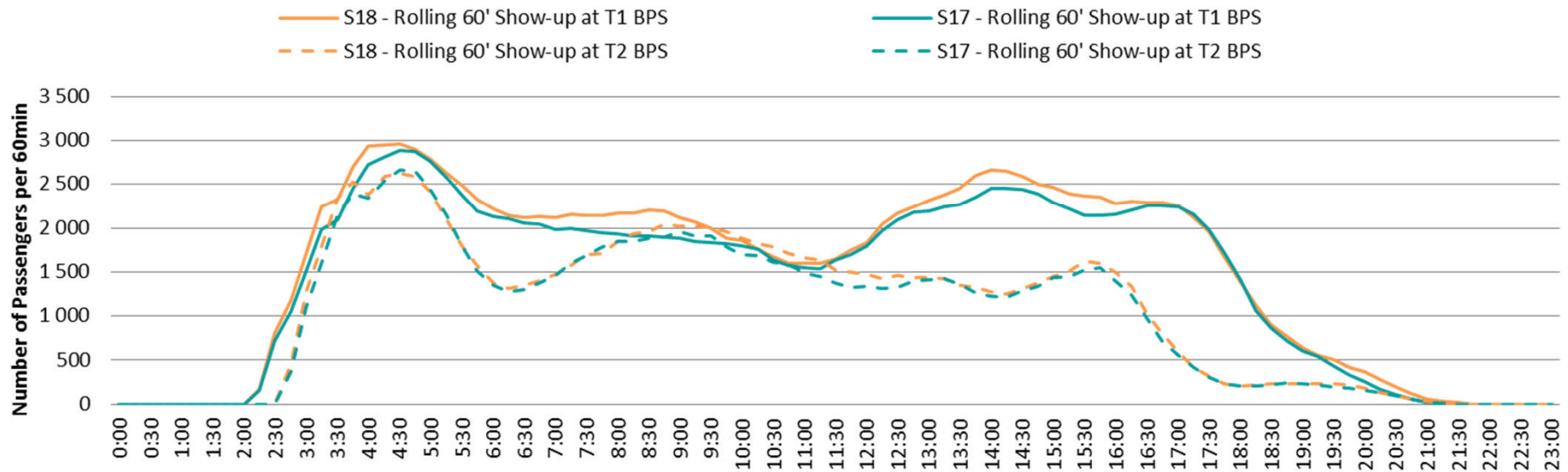


Passenger Terminal Buildings

Departure Processes – Flight Schedule Changes

The S18 flight schedule as assigned to the model and changes against the S17 scenario are reflected in the Passenger Show-up at T1 and T2 Boarding Pass Scan (BPS) process.

Show-Up Profiles at T1&T2 Boarding Pass Scan per 60min period



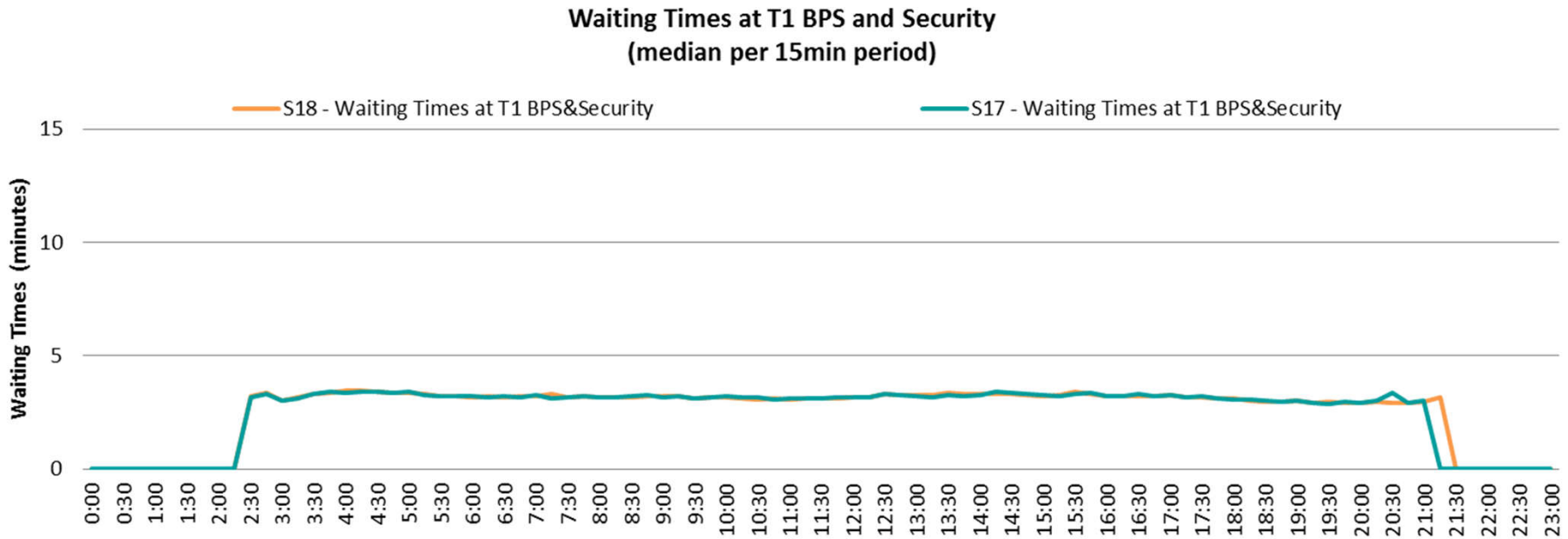
Passenger Terminal Buildings

Departure Processes – T1 BPS + Security

Definition: The delay experienced from the time a passenger joins the queue before the Boarding Pass Scan (BPS) until the time the passenger enters the Security Lane.

With all security lanes opened at T1, the passengers are accommodated with a good level of service: the difference in waiting times is negligible.

The proposed S18 changes have no significant impact on the performance of T1 security process.



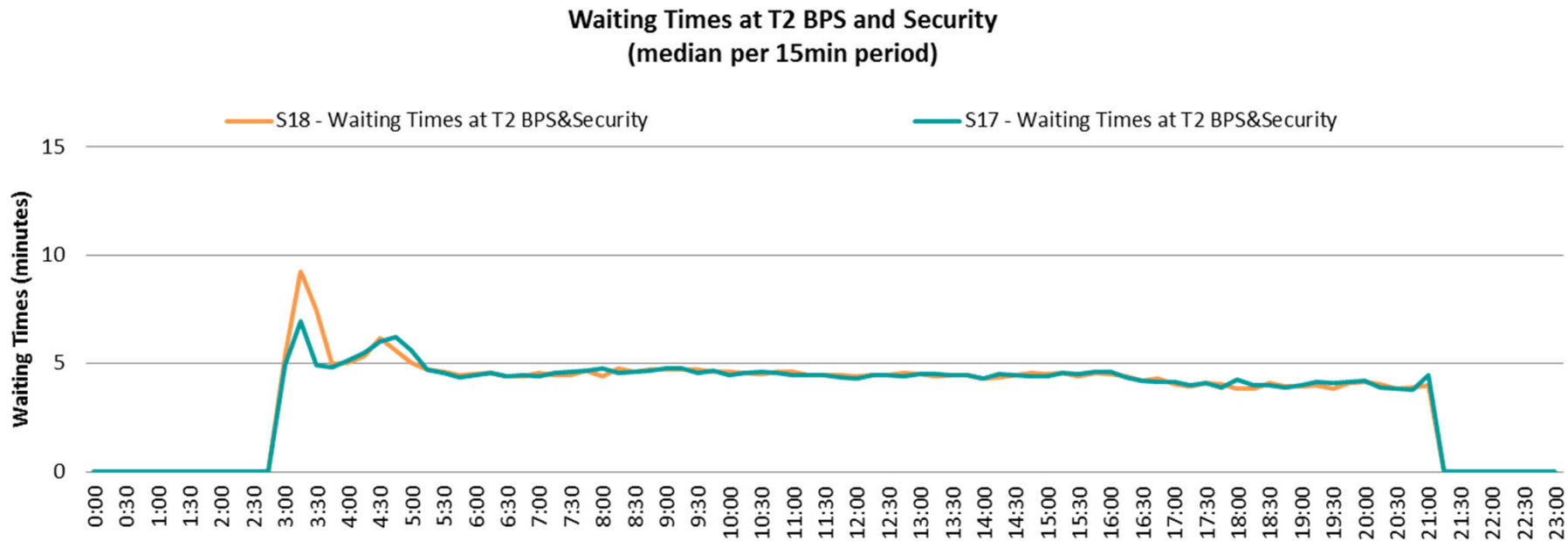
Passenger Terminal Buildings

Departure Processes – T2 BPS + Security

Definition: The delay experienced from the time a passenger joins the queue before the Boarding Pass Scan (BPS) until the time the passenger enters into a Security Lane.

With all security lanes opened at T2, the passengers are accommodated with a good level of service: the difference in waiting times is negligible.

The proposed S18 changes have no significant impact on the performance of T2 security process.



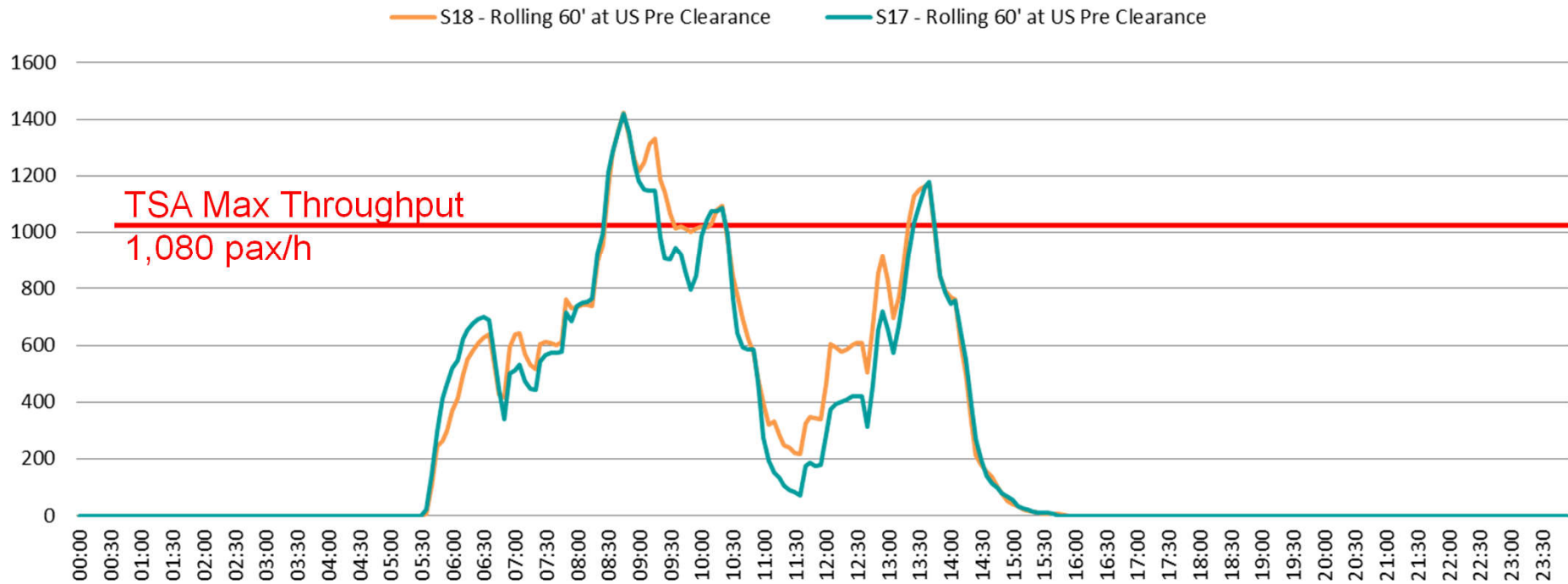
PTB

US Pre-clearance Processes – Show-up at TSA

Both the S18 forecast and the S17 baseline generate peaks above TSA capacity. S17 generate 1,419 passengers from 0845 to 0940 UTC. This would correspond to 1,206 passengers if 85% load factor has been used.

The TSA Security Control with an estimated maximum throughput of 1,080 pax/h (20 sec/pax; 6 lanes) is the limiting element, likely to generate delays.

Rolling 60' at US Pre Clearance area

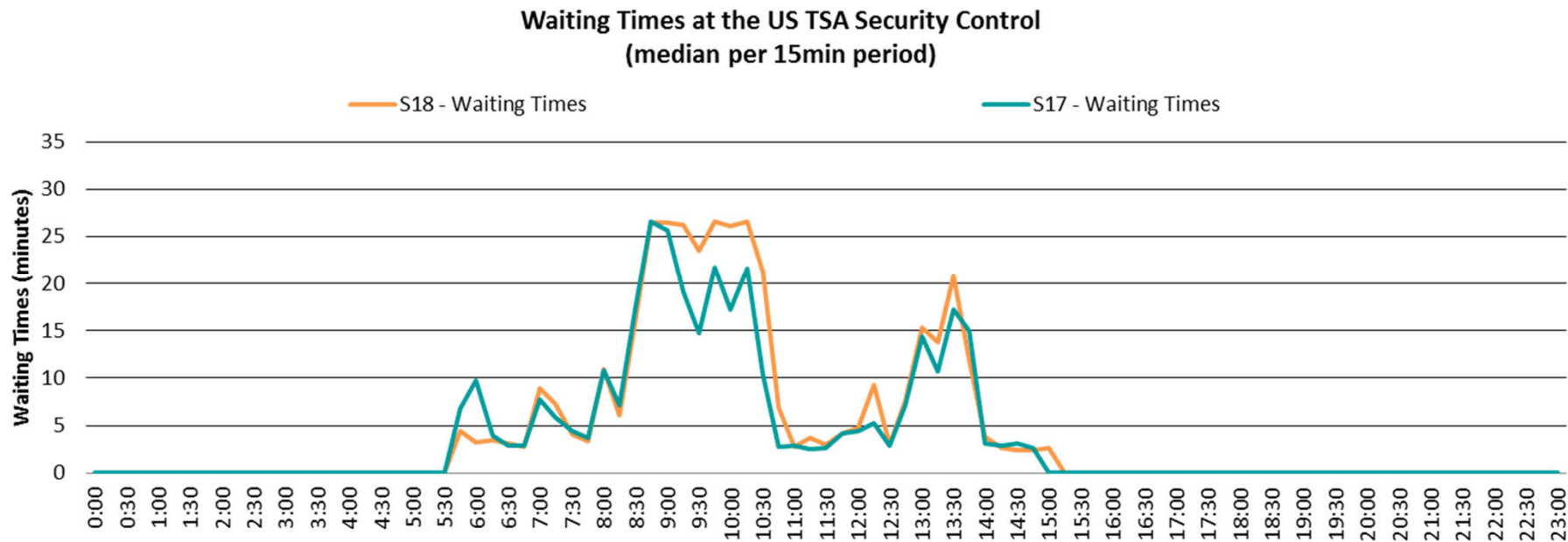


PTB

US Pre-clearance Processes – Waiting times at TSA

Definition: The delay experienced from the time a passenger joins the queue before Document Check in the US Pre-Clearance Area until the time the passenger enters into a TSA Security Lane.

Due to the major flow of passengers entering this area from 0845 to 0940 UTC the waiting times increase significantly and congestion is seen in the limited ground floor area.



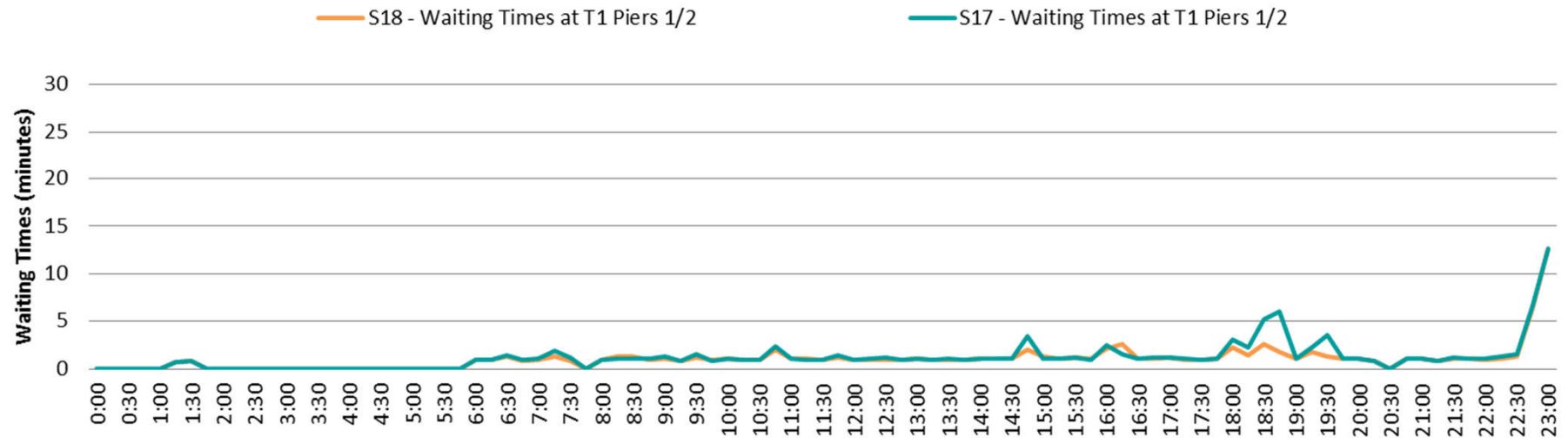
Passenger Terminal Buildings

Arrival Processes – Immigration

Definition: The delay experienced from the time a passenger enters the queue before Immigration until the moment the passenger gets access to a booth or to an e-gate.

With all immigration booths fully staffed at T1, the forecast S18 additions to the flight schedule will have no significant impact on performance. The introduction of 10 e-gates at T1 will have the impact of reducing waiting times at previously congested periods.

**Waiting Times at T1 Piers 1/2 Immigration
(median per 15min period, all pax)**

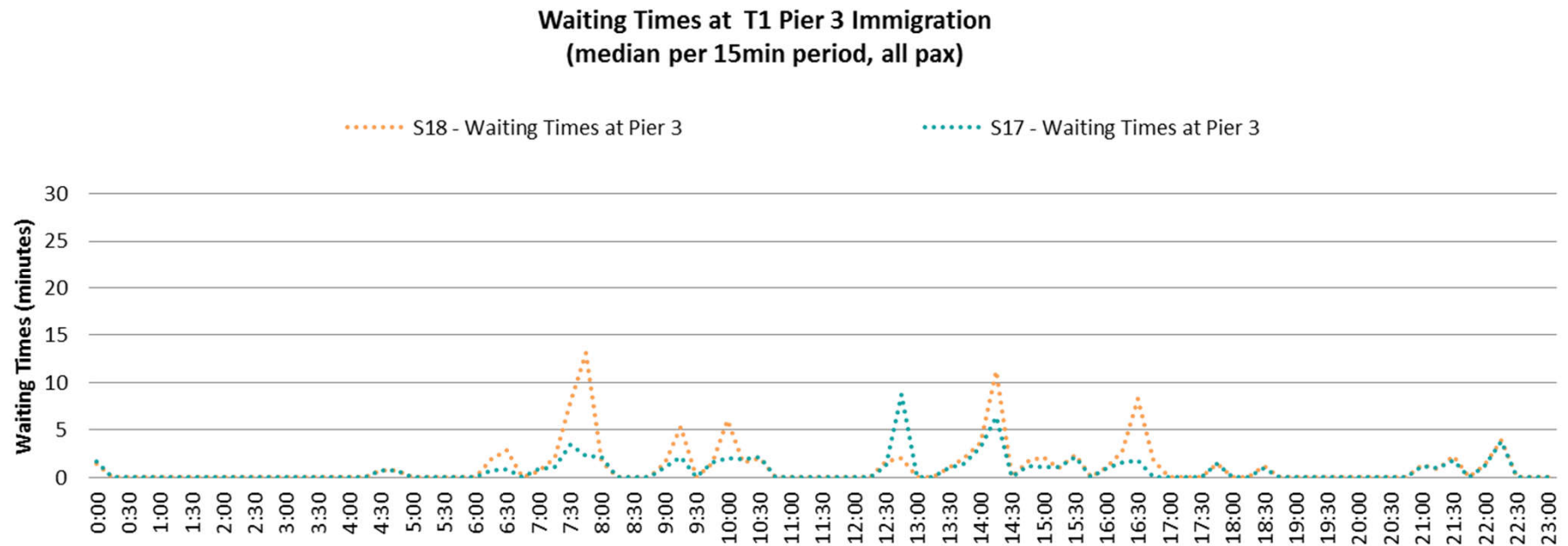


Passenger Terminal Buildings

Arrival Processes – Immigration

Definition: The delay experienced from the time a passenger enters the queue before Immigration until the moment the passenger gets access to a booth.

The introduction of additional flights at Pier 3 explains increasing waiting times at Pier 3 immigration control.

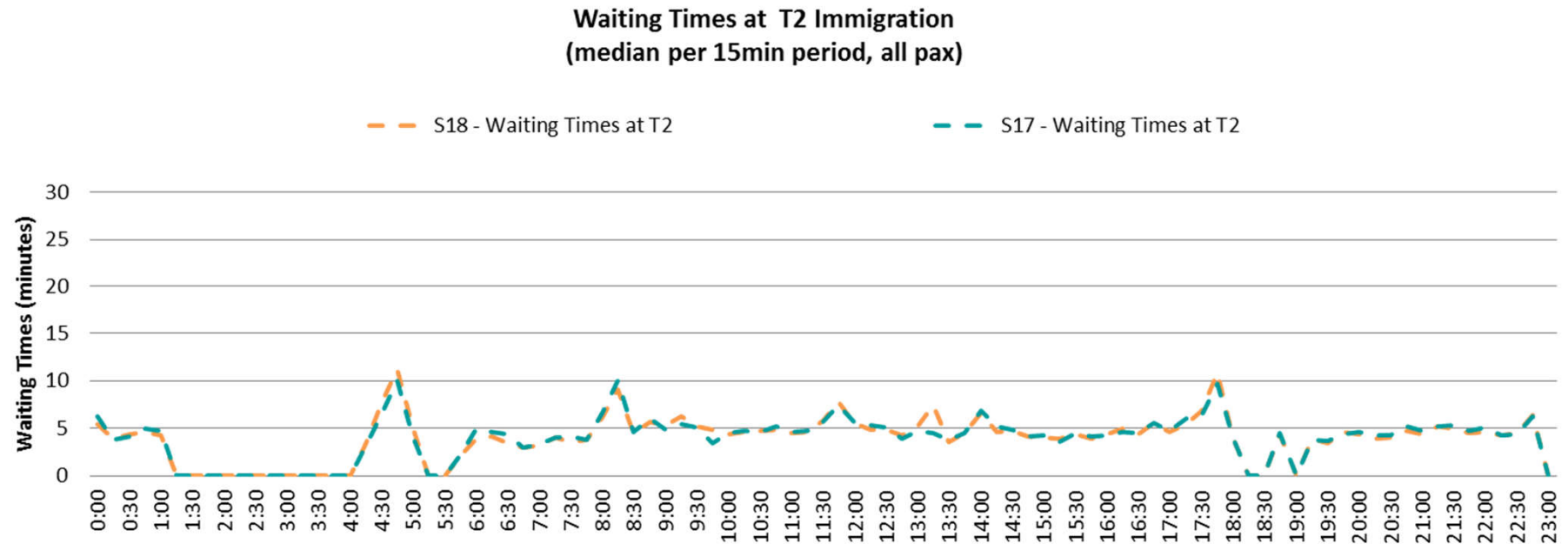


Passenger Terminal Buildings

Arrival Processes – Immigration

Definition: The delay experienced from the time a passenger enters the queue before Immigration until the moment the passenger gets access to a booth or to an e-gate.

With all immigration booths fully staffed at T2, the proposed S18 changes to the flight schedule will have no significant impact on performance. The introduction of 10 e-gates at T2 will have the impact of reducing waiting times, at previously congested times.



Findings

Airside (Runway 28)

- Implementation of proposed hourly increases in S18 forecast schedule on performance in the design day is likely to:
 - Increase average daily departure taxi out time by an average of 1.5 minute per flight
 - Increase average daily departure ground delay by over one minute per flight
 - Increase average departure ground delays of flights operating in the morning peak period and between 1730 – 1800 UTC by more than 5 minutes per flight
 - Have slightly detrimental impact on average arrival taxi duration
 - Have no significant impact on average arrival ground delay

Airside (Runway 28)

Metric	Period	S17	S18	Difference
Departure taxi out time	Daily average	00:11:03	00:12:32	00:01:29
Departure taxi out time	Peak average	00:20:09	00:25:47	00:05:38
Runway holding delay	Daily average	00:03:19	00:04:19	00:01:00
Runway holding delay	Peak average	00:10:18	00:15:11	00:04:53
Departure ground delay	Daily average	00:03:52	00:05:09	00:01:17
Departure ground delay	Peak average	00:11:19	00:16:55	00:05:36
Arrival taxi time	Daily average	00:06:05	00:06:19	00:00:14
Arrival taxi delay	Daily average	00:00:53	00:00:53	00:00:00

Airside (Runway 10)

- Implementation of proposed hourly increases in S18 forecast schedule on performance in the design day is likely to:
 - Increase average daily departure taxi out time by an average of 1.5 minute per flight
 - Increase average daily departure ground delay by over one minute per flight
 - Increase average departure ground delays of flights operating in the peak periods by 4 minutes per flight
 - Increase average daily arrival taxi time by over one minute per flight
 - Have no significant impact on average arrival ground delay

Airside (Runway 10)

Metric	Period	S17	S18	Difference
Departure taxi out time	Daily average	00:13:44	00:15:13	00:01:29
Departure taxi out time	Peak average	00:24:47	00:29:07	00:04:20
Runway holding delay	Daily average	00:02:38	00:03:52	00:01:14
Runway holding delay	Peak average	00:10:14	00:14:28	00:04:14
Departure ground delay	Daily average	00:03:22	00:04:46	00:01:24
Departure ground delay	Peak average	00:11:27	00:15:28	00:04:01
Arrival taxi time	Daily average	00:03:44	00:04:05	00:00:21
Arrival taxi delay	Daily average	00:00:31	00:00:50	00:00:19

Terminal buildings

- The additional flights that are proposed to be added to the S17 schedule will have no detrimental effect on the processing ability of the terminal building. It is noted that such an assessment has been carried out assuming that all of the processing facilities that are presently located in the passenger terminal building are fully staffed.
- The PTB could accept more departing passengers all along the day.
- The changes to the early morning departures wave is not increasing the waiting times at Security significantly.
- The TSA Security Process is the limiting element to the capacity of the US Pre-clearance area and any additional flights to the US should be assessed individually.
- The overall arrival capacity is sufficient, however, the waiting times at T2 Immigration increase during the first morning wave of arrivals.
- The introduction of 20 e-gates before Summer 18 is likely to decrease immigration waiting times.

Next steps

- Completion of the study, including:
 - Assessment of R10/28 capacity scenario
 - Assessment of capacity implications related to hypothetical changes in delay criteria
 - Assessment of the need for firebreaks
 - Assessment of maximum capacity when coordinating to 5 minute periods