HELIOS

The aviation consultancy of Egis

HIGH-LEVEL PERFORMANCE REVIEW OF AIRSIDE CAPACITY PROJECTS

PREPARED IN SUPPORT OF CIP2020 EVALUATION PROCESS

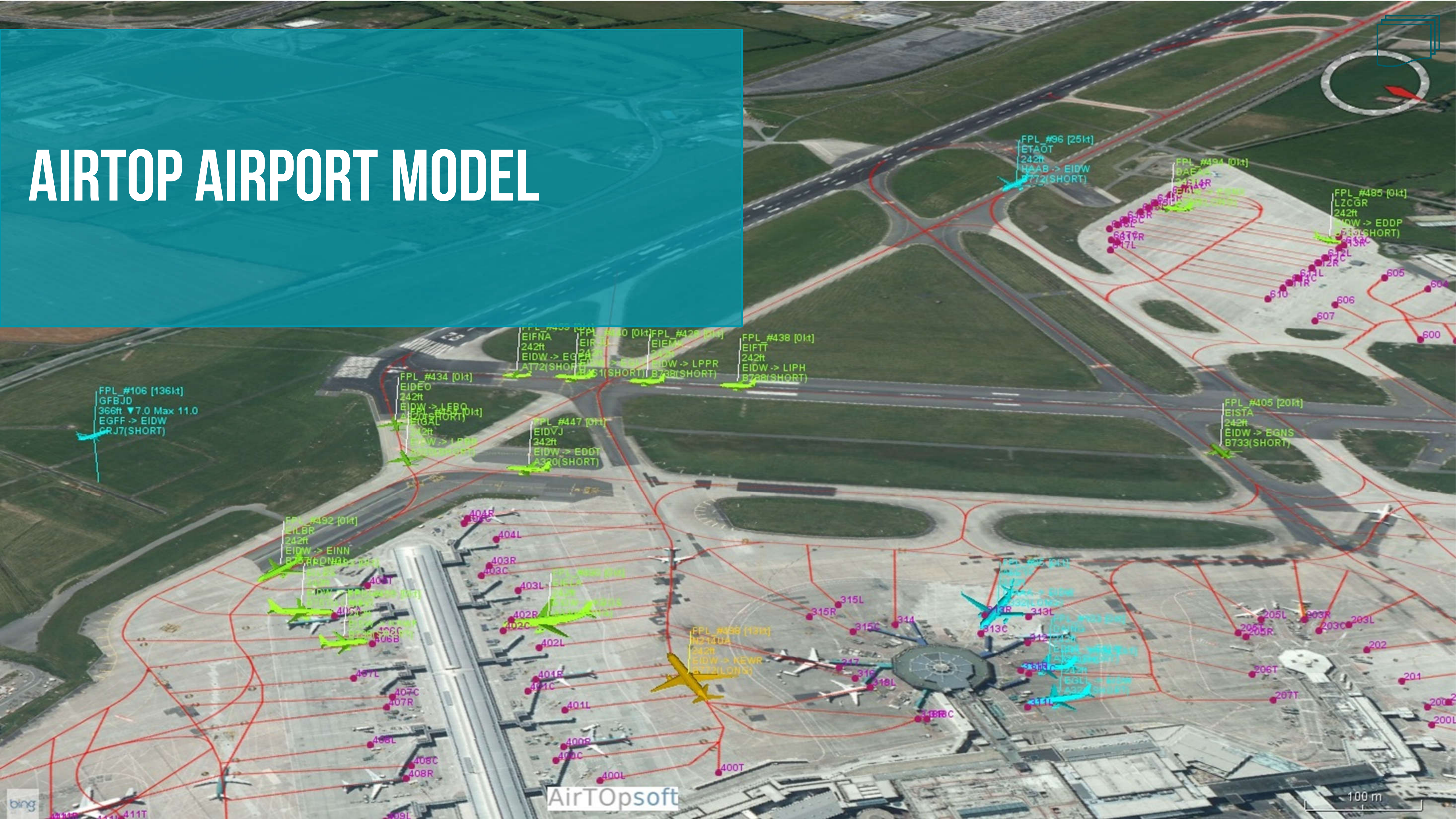
an egis company

CONTEXT

- In January 2019, the Commission for Aviation Regulation (CAR) published the final version of Dublin Airport Authority (daa) Capex Investment Programme 2020+ (CIP) outlining daa's intended airport development projects.
- CAR is the body responsible for review and approval of the CIP, in terms of deciding if and how the associated funding can be recovered from airport users in the form of Airport Charges.
- CAR requested Helios to perform a high-level feasibility and operational impact assessment of the selected CIP projects on airfield performance.
- This document represents assessment of selected airside projects.
- Assessment of selected terminal building projects is provided separately.

CONTENTS

AIRTOP AIRPORT MODEL



THE METHODOLOGY FOLLOWED WAS:

- Consultations with daa and IAA to understand the target operating concept and any potential limitations of the future airfield layout.
- Agreement with CAR on what elements of CIP to model.
- Data collection, validation and pre-processing.
- Update of the existing fast-time simulation model of Dublin airport*.
- Review of the updated model with representatives of CAR, daa and IAA.
- Implementation of the feedback received during the model review process.
- <u>High-level</u> qualitative and quantitative assessment of selected airside metrics.

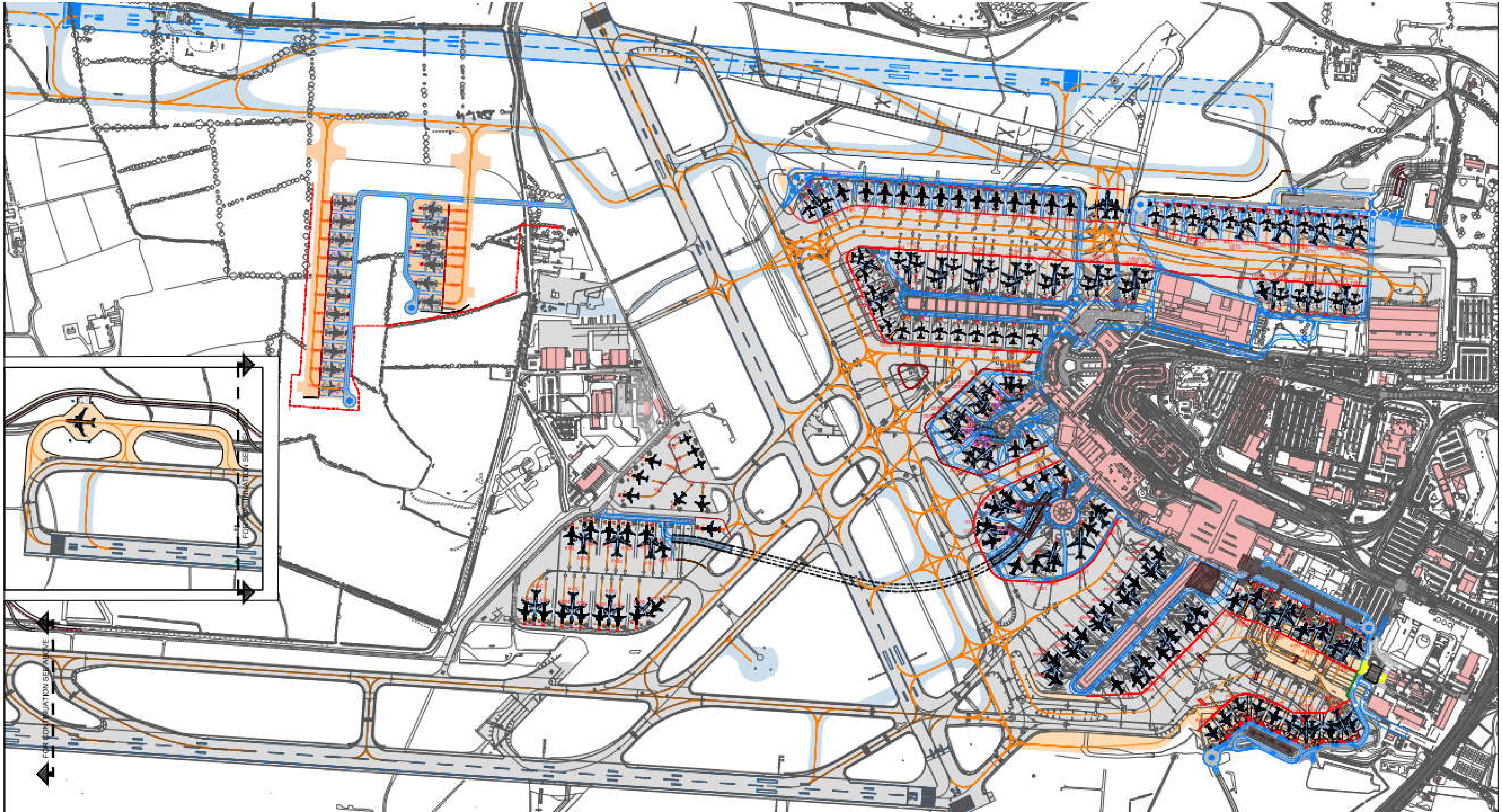
* Helios developed a FTS model of Dublin airport in 2017 and since then this model has been used in support of several seasonal capacity declarations as well as for assessment of daa's PACE (Programme of Airport Campus Enhancement) projects.

DATA AND ASSUMPTIONS USED

- CAD drawings of the existing and future airfield layout provided by daa,
- Flight schedule* representing a future ‘busy day’ provided by daa,
- Assumed airside and airspace operational concept provided by both daa and IAA,
- Other model-specific input data and assumptions provided by daa and IAA.

* The flight schedule is consistent with expected 40 million passengers per annum (mppa) traffic level

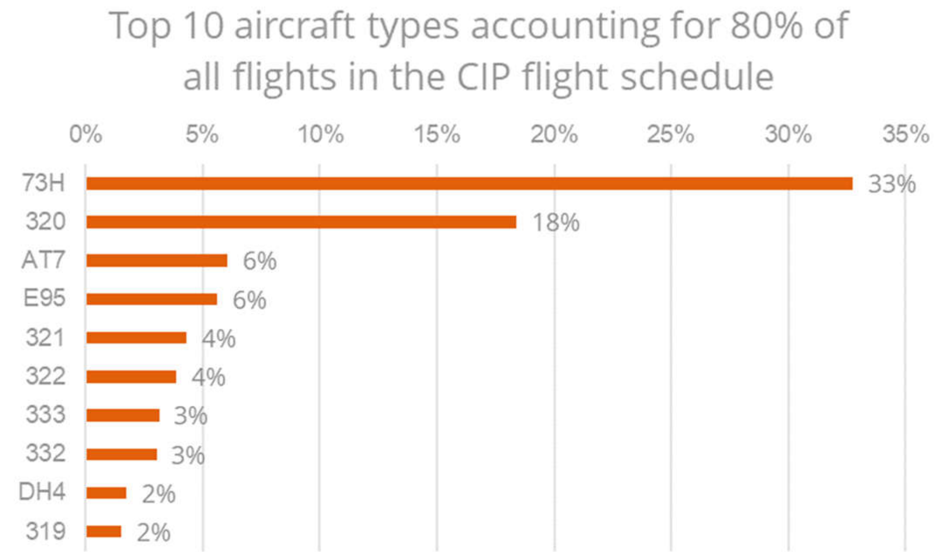
CAD DRAWING USED TO UPDATE THE MODEL'S AIRFIELD LAYOUT

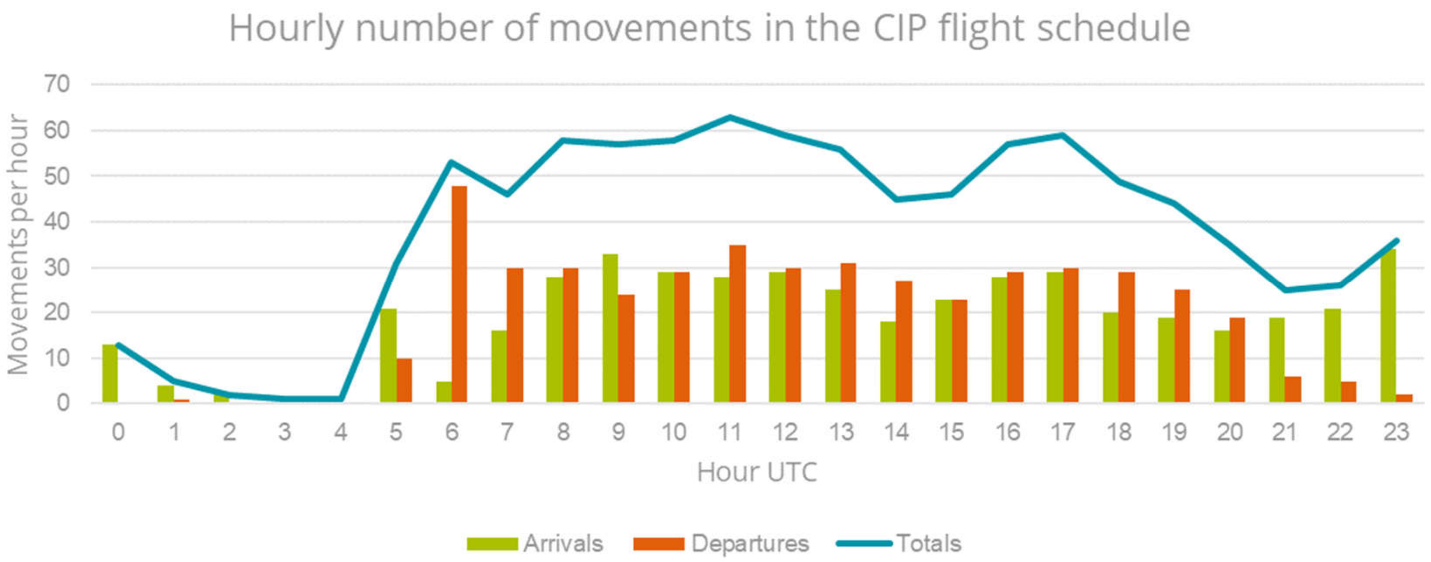


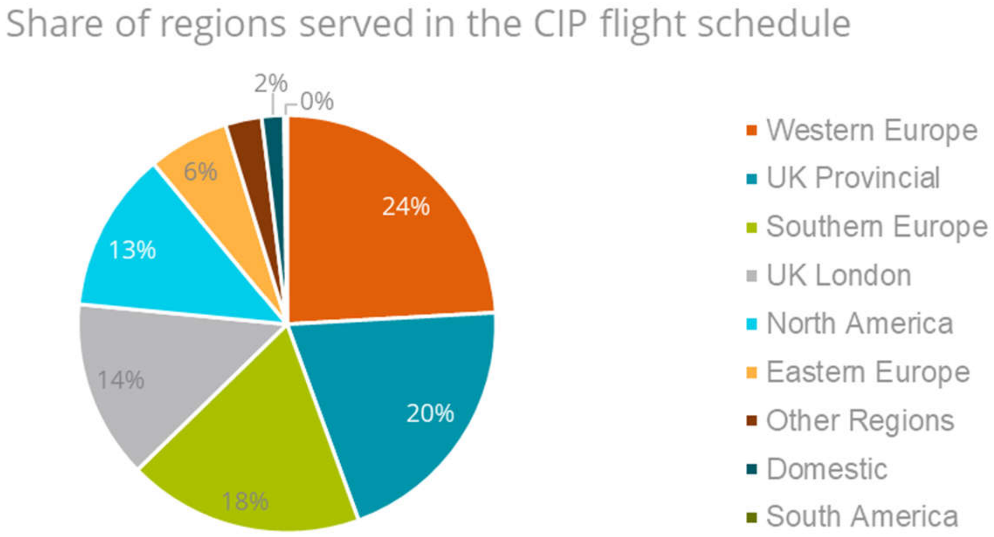
OVERVIEW OF THE FLIGHT SCHEDULE USED

The flight schedule modelled contains:

- 925 flights split 461 arrivals and 464 departures,
- 143 long haul and 782 short haul flights,
- 861 scheduled passenger services, 37 general aviation flights, 10 cargo flights, 10 passenger charter flights, 2 technical stops, 2 air ambulance flights, 2 cargo charter flights and 1 positioning flight.







ASSUMED OPERATING CONCEPT

- CIP2020+ foresees existence of the new runway (28R), parallel to the existing runway 28L.
- As Dublin airport operates in a westerly direction approximately 70% of the time*, only operations on runways 28L and 28R were simulated.
- As the final operating concept for a 2 runway Dublin airport is still being finalised, the following has been assumed, based on the best current information, for the purpose of our CIP2020 simulations:

Runway operating mode	From	To	Arrival runway	Departure runway
Single	00:00:00	05:59:59	28L	28L
Mixed	06:00:00	07:59:59	28L	28L and 28R
Segregated	08:00:00	23:59:59	28L	28R

- Depending on the runway operating mode, different flows of traffic on taxiways can be expected.

* This figure varies by cca +/-10% by season

KEY ASSUMPTIONS USED IN THE MODEL

(RUNWAY OPERATIONS)

- Existing STARs used to feed RWY 28L arrivals,
- Existing SIDs from RWY 28L used when operating in mixed mode,
- Departure tracks from RWY 28R offset by 15 and 60 degrees from the runway centerline,
- When the southern runway operates in mixed mode:
  - departures from RWY 28L are allowed to the south sector only,
  - departures from RWY 28L are only allowed to turn left,
  - departures from RWY 28R are allowed to the north sector only,
  - departures from RWY 28R are only allowed to turn right,
  - RWY 28L departures from Pier 1 and Pier 2 queue on R16-34,
  - RWY 28L departures from Pier 3 and Pier 4 queue on taxiway F.

KEY ASSUMPTIONS USED IN THE MODEL
(AIRCRAFT SEPARATIONS)

Arrival – arrival separations

Leading	Following			
	Light	Medium	Heavy	Super
Light	3 NM	3 NM	3 NM	3 NM
Medium	5 NM	3 NM	3 NM	3 NM
Heavy	6 NM	5 NM	4 NM	4 NM
Super	8 NM	7 NM	6 NM	4 NM

Departure – departure separations

Leading	Following			
	Light	Medium	Heavy	Super
Light	84 sec	84 sec	84 sec	84 sec
Medium	120 sec	84 sec	84 sec	84 sec
Heavy	120 sec	120 sec	100 sec	100 sec
Super	120 sec	120 sec	120 sec	120 sec

- If the departure tracks from RWY 28R deviate by more than 45 degrees, the D-D separations can be reduced to 60 seconds.
- Arriving aircraft needs to be more than 2NM from RWY 28L threshold for the departure on the RWY 28L holding point to be cleared to enter the runway/take off.
- A-D-A separation kept at a minimum of 5.5 NM.
- ICAO Wake Vortex separations applied as required.

There are ongoing initiatives to reduce aircraft separations - if these initiatives are successful it could be expected the future airfield would operate more efficiently. However it would be speculative to try and predict how these initiatives might develop in the coming years, so the existing separations were used in the model.

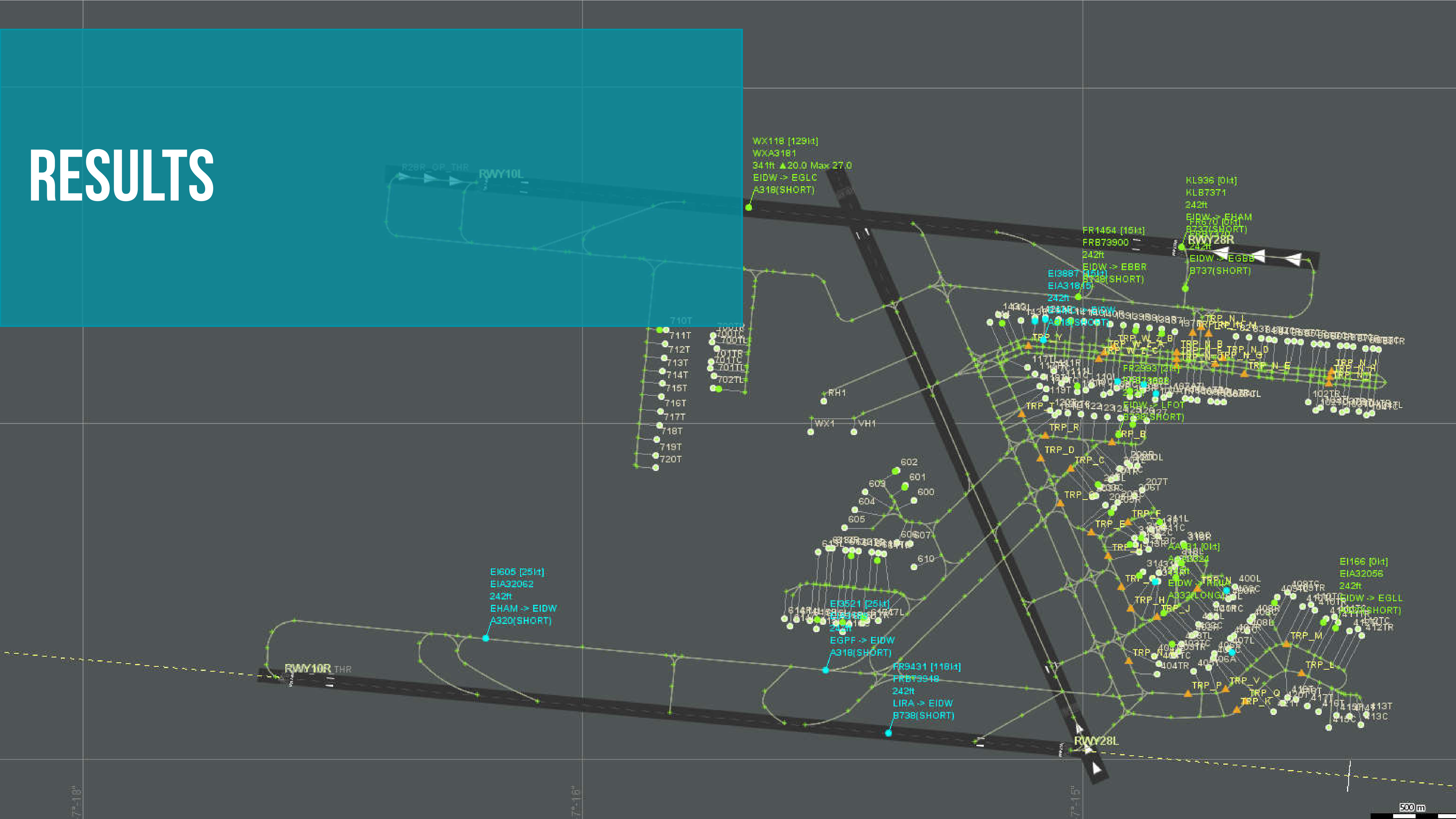
KEY ASSUMPTIONS USED IN THE MODEL

(TAXIWAY FLOWS)

KEY ASSUMPTIONS USED IN THE MODEL
(OTHER ASSUMPTIONS)

- Stand allocation based on flight schedule provided.
  - When in conflict, rule based engine based on historic data and airline preferences allocated flights to available parking positions.
- Speeds in linear hold (Point Merge):
  - Outer arc: 230 kts
  - Off-arc: 210 kts
  - LAPMO: 190 kts
  - MAXEV: 165 kts
- Aircraft performance as per AirTOp performance tables.

RESULTS



RWY10L
RWY28R
RWY10R
RWY28L
WX118 [129kt]
WXA3181
341ft ▲20.0 Max 27.0
EIDW -> EGLC
A318(SHORT)
KL936 [0kt]
KLB7371
242ft
EIDW -> EHAM
FR1454 [15kt]
FRB73900
242ft
EIDW -> EBBR
B738(SHORT)
EIDW -> EGBB
B737(SHORT)
EI605 [25kt]
EIA32062
242ft
EHAM -> EIDW
A320(SHORT)
EI3521 [25kt]
EGPF -> EIDW
A318(SHORT)
FR9431 [118kt]
FRB73948
242ft
LIRA -> EIDW
B738(SHORT)
EI166 [0kt]
EIA32056
242ft
EIDW -> EGLL
EIDW -> LFOT
B738(SHORT)
WX1
VH1
RH1
500 m

METRICS MEASURED

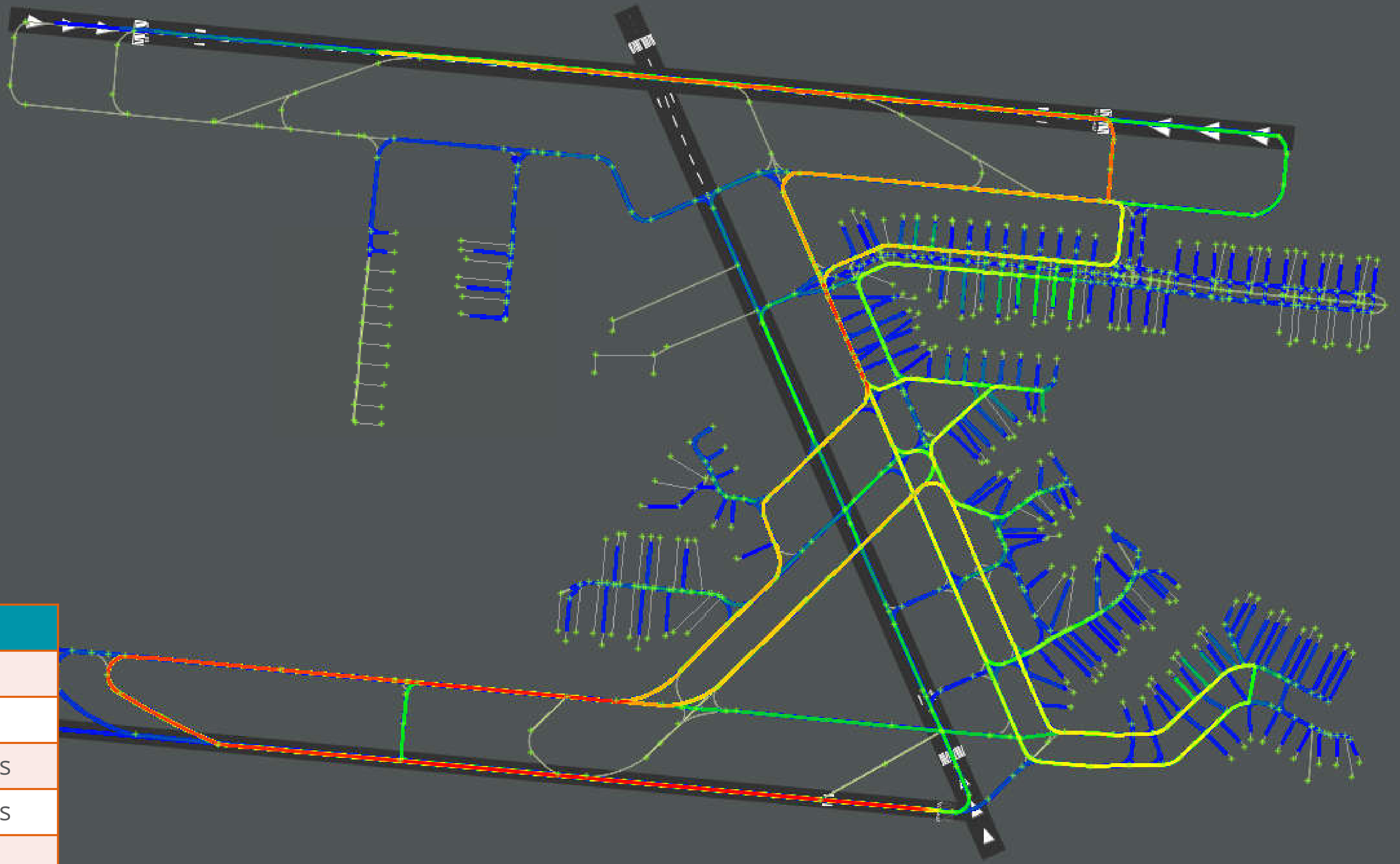
Metric	Definition
Departure taxi out time	Is defined to be the time period between off-block and the time the aircraft reaches its stop bar for runway entry. This value is updated every second of simulation time when the aircraft is taxiing for departure even if the aircraft is stationary.
Arrival taxi in time	Is defined to be the time duration the arriving aircraft has been taxiing between vacating the runway and reaching its final parking position. This value is updated every second of simulation time when the aircraft is taxiing to its arrival stand even if the aircraft is stationary.
Departure runway holding delay	Is defined as 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 throughput	Is defined as the sum of all aircraft touching down and lifting-off within a 60minutes rolling period. For departures, the count is incremented every time the aircraft passes over the opposite end of runway. For arrivals, the count is incremented every time the aircraft touches down.
Stand demand	Is expressed as number of C-code equivalent stands being occupied at any time during the simulation. In case of stands in MARS configuration, the centre position counts as two Code C equivalent parking positions.
Average delay accumulated on taxiway segments	Is defined as the average duration per aircraft which have spent at least 1 second stopped on the taxiway during the monitored period. It is calculated as the delay duration of all aircraft on the taxiway divided by the total occupancy during the monitored period.
Number of aircraft stoppings on taxiway segments	Is defined as the number of times an aircraft had to be stopped on the taxiways during the monitored period. This metric includes all reasons for stopping.

*Taxi time metrics are measured in rolling 10 minute windows.

TAXIWAY FLOWS

AIRCRAFT GROUND TRAJECTORIES – ALL TRAFFIC

(DENSITY MAP SHOWING FREQUENCY OF USE OF THE TAXIWAY NETWORK)

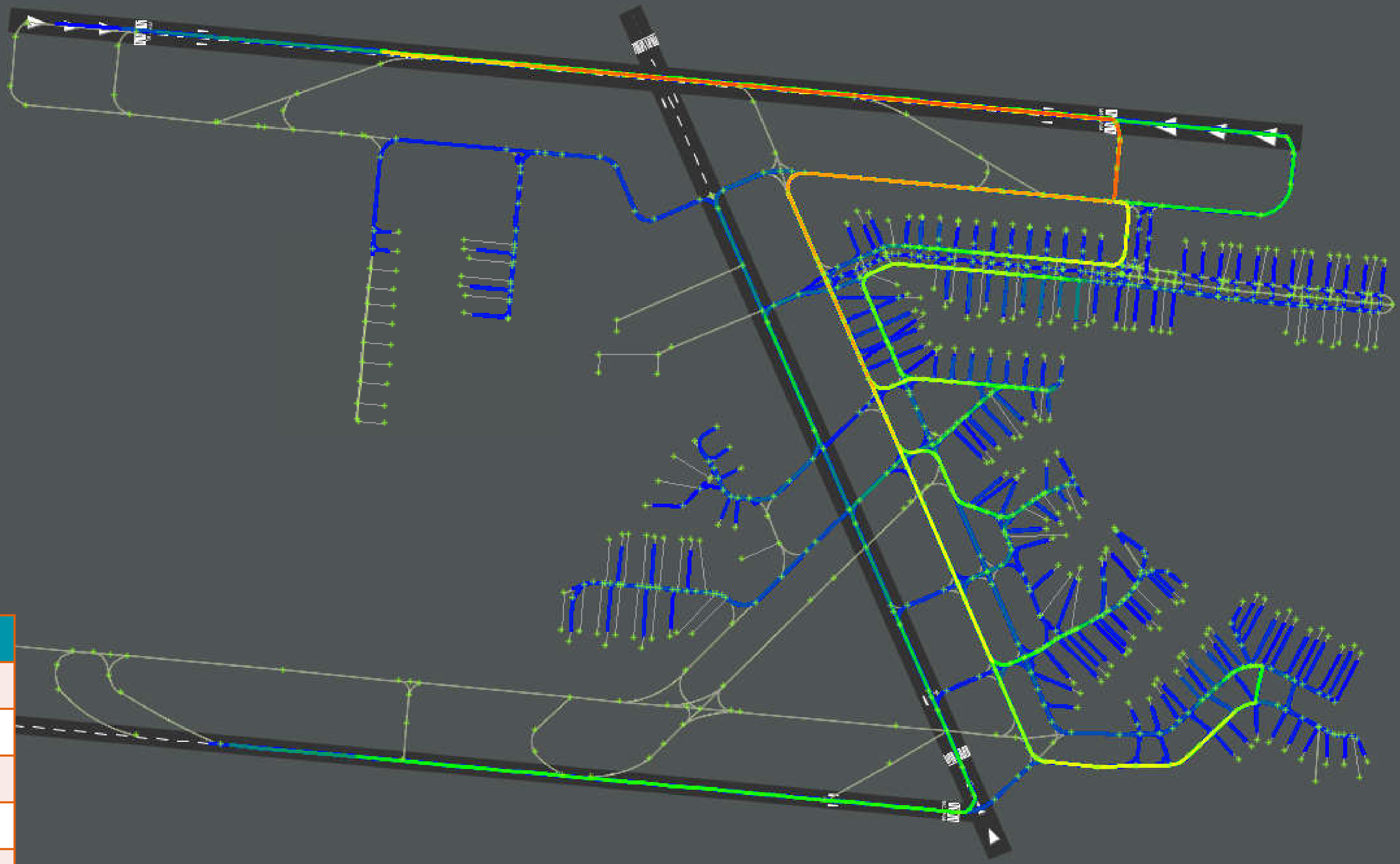


Legend

Blue	0 – 50 mvts
Green	50 – 100 mvts
Yellow	100 – 200 mvts
Orange	200 – 500 mvts
Red	> 500 mvts

AIRCRAFT GROUND TRAJECTORIES - DEPARTURES

(DENSITY MAP SHOWING FREQUENCY OF USE OF THE TAXIWAY NETWORK)

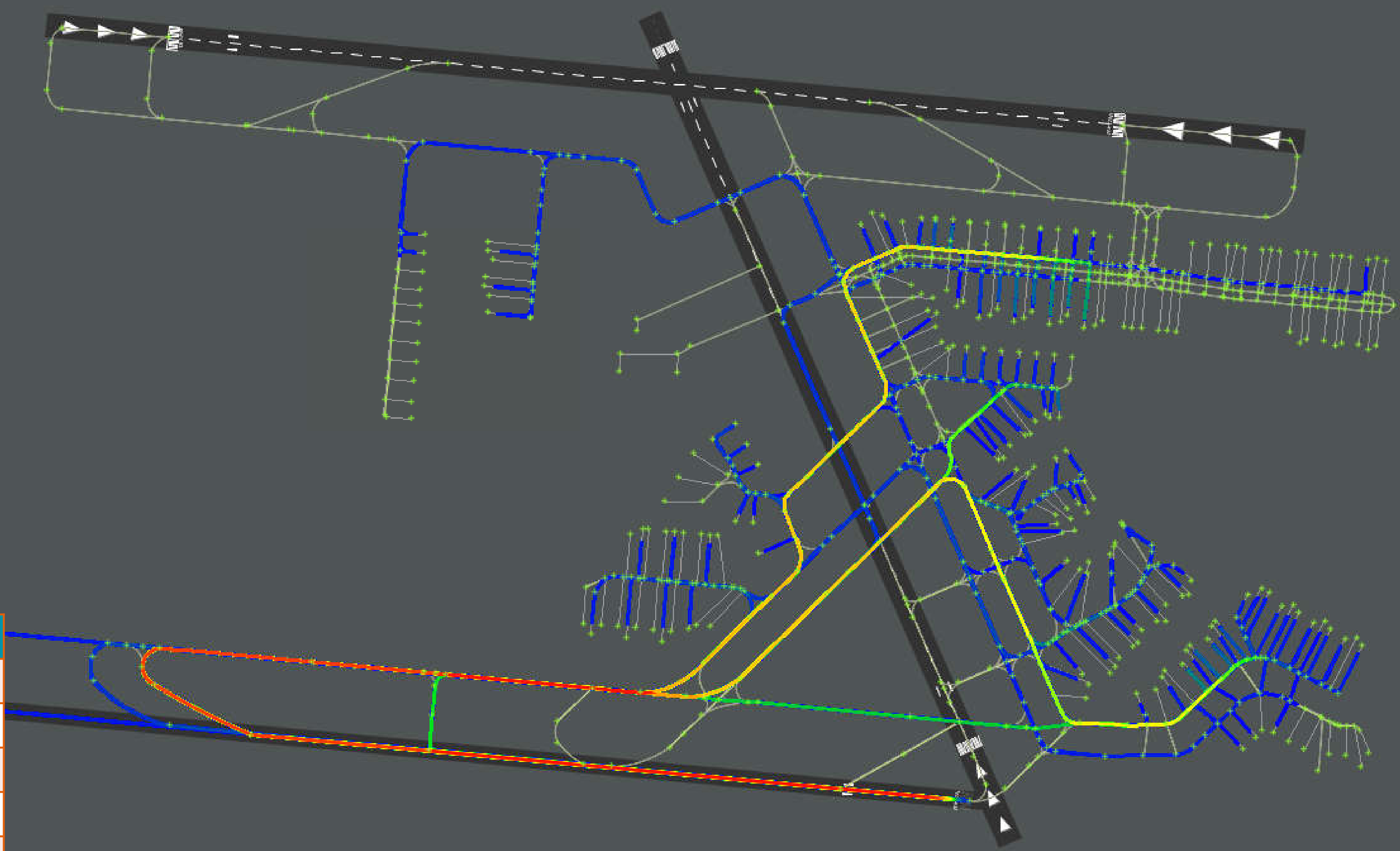


Legend

Blue	0 – 50 mvts
Green	50 – 100 mvts
Yellow	100 – 200 mvts
Orange	200 – 500 mvts
Red	> 500 mvts

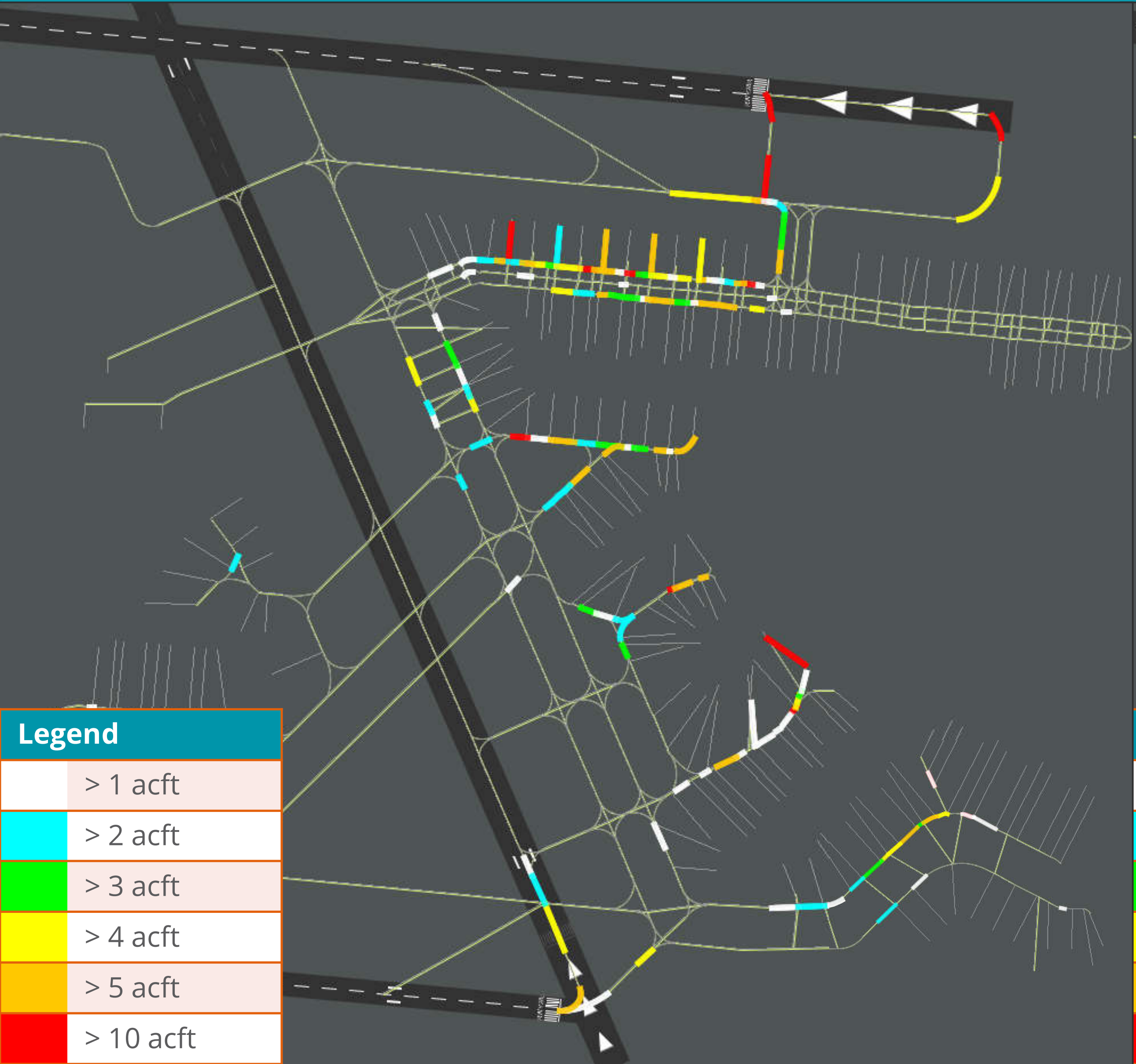
AIRCRAFT GROUND TRAJECTORIES - ARRIVALS

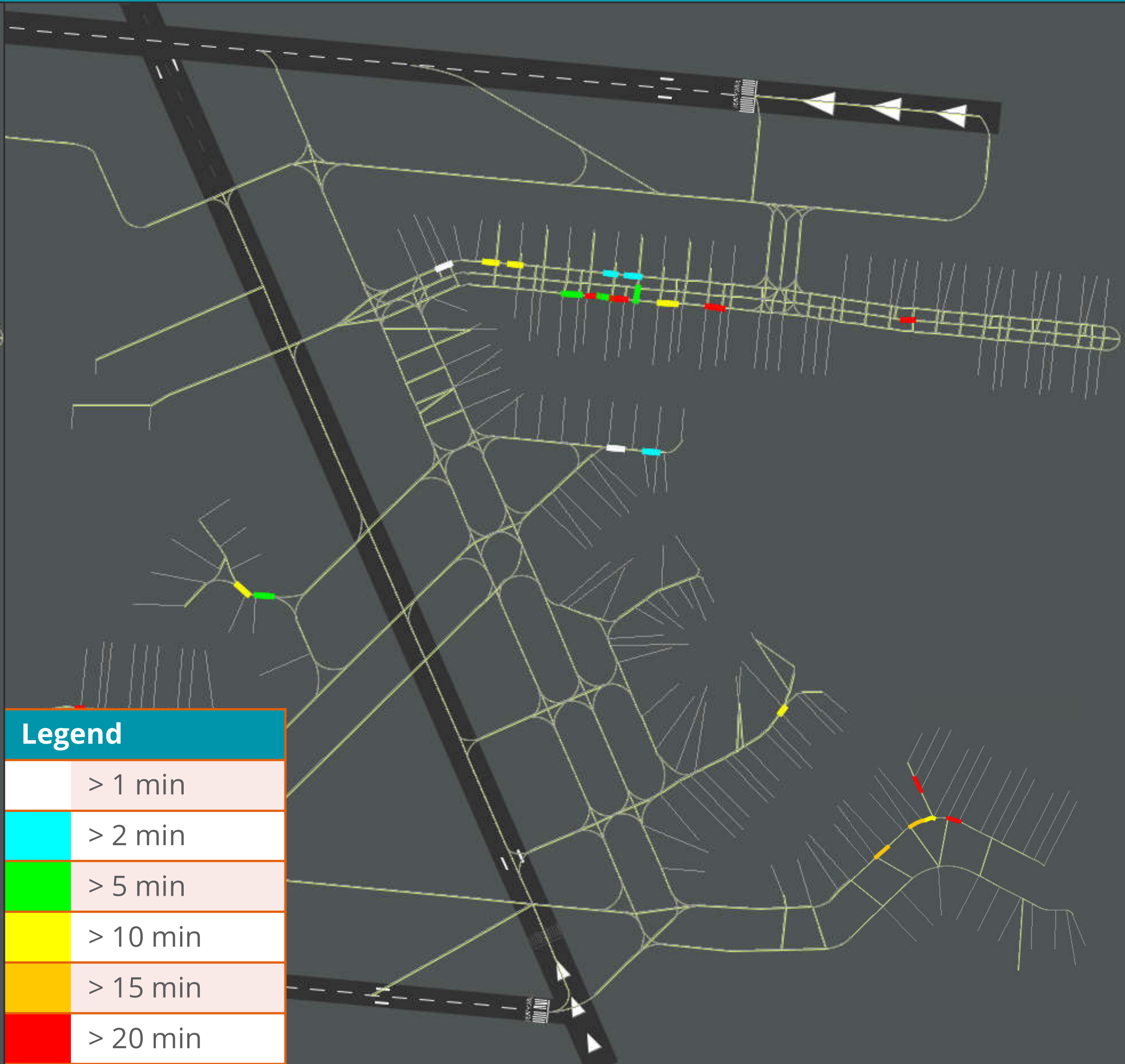
(DENSITY MAP SHOWING FREQUENCY OF USE OF THE TAXIWAY NETWORK)



Legend	
	0 – 50 mvts
	50 – 100 mvts
	100 – 200 mvts
	200 – 500 mvts
	> 500 mvts

NO. OF AIRCRAFT STOPPINGS ON TAXIWAY SEGMENTS THROUGHOUT THE DAY (LEFT)
AV. DELAY DURATION ON TAXIWAY SEGMENTS THROUGHOUT THE DAY (RIGHT)



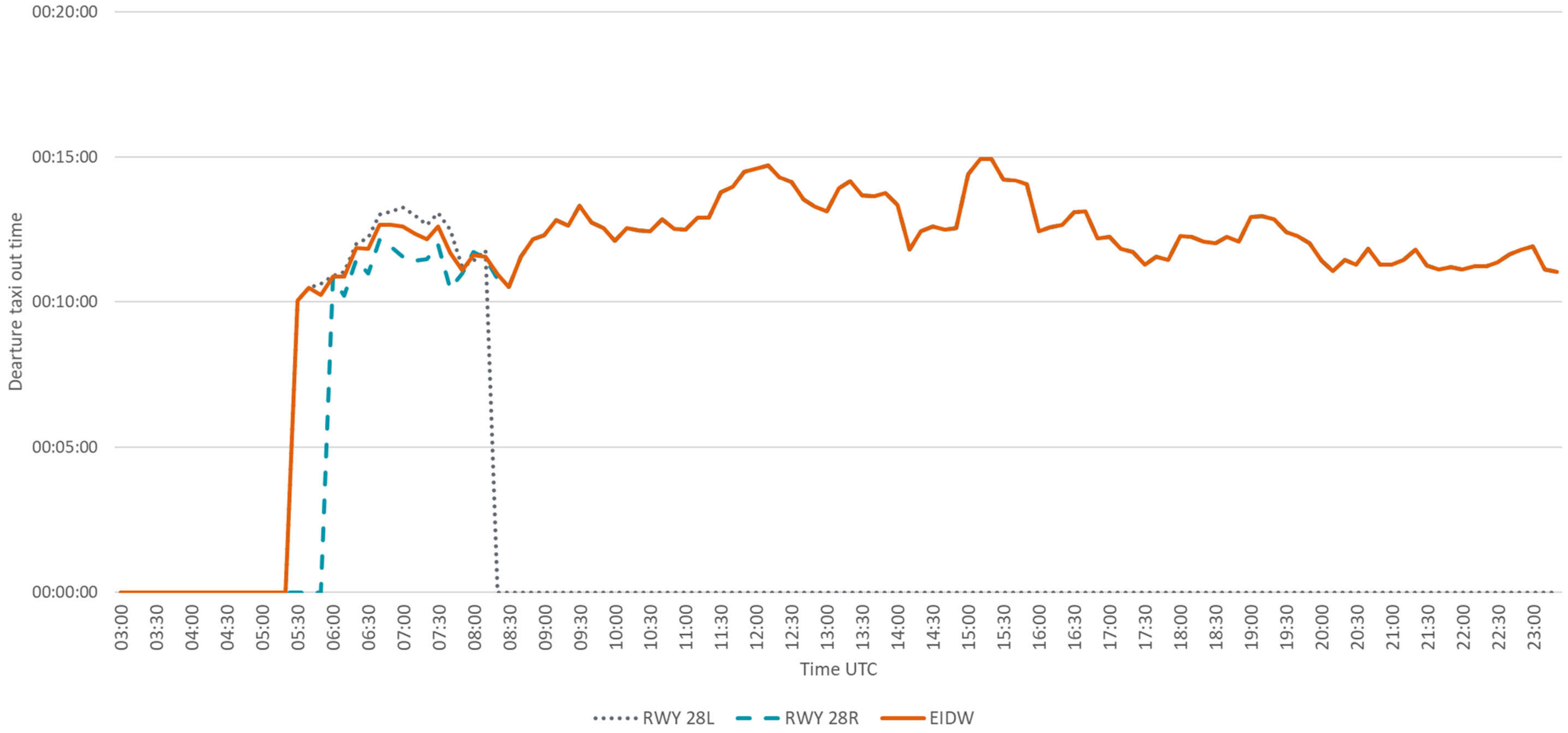


TAXIWAY FLOWS - OBSERVATIONS

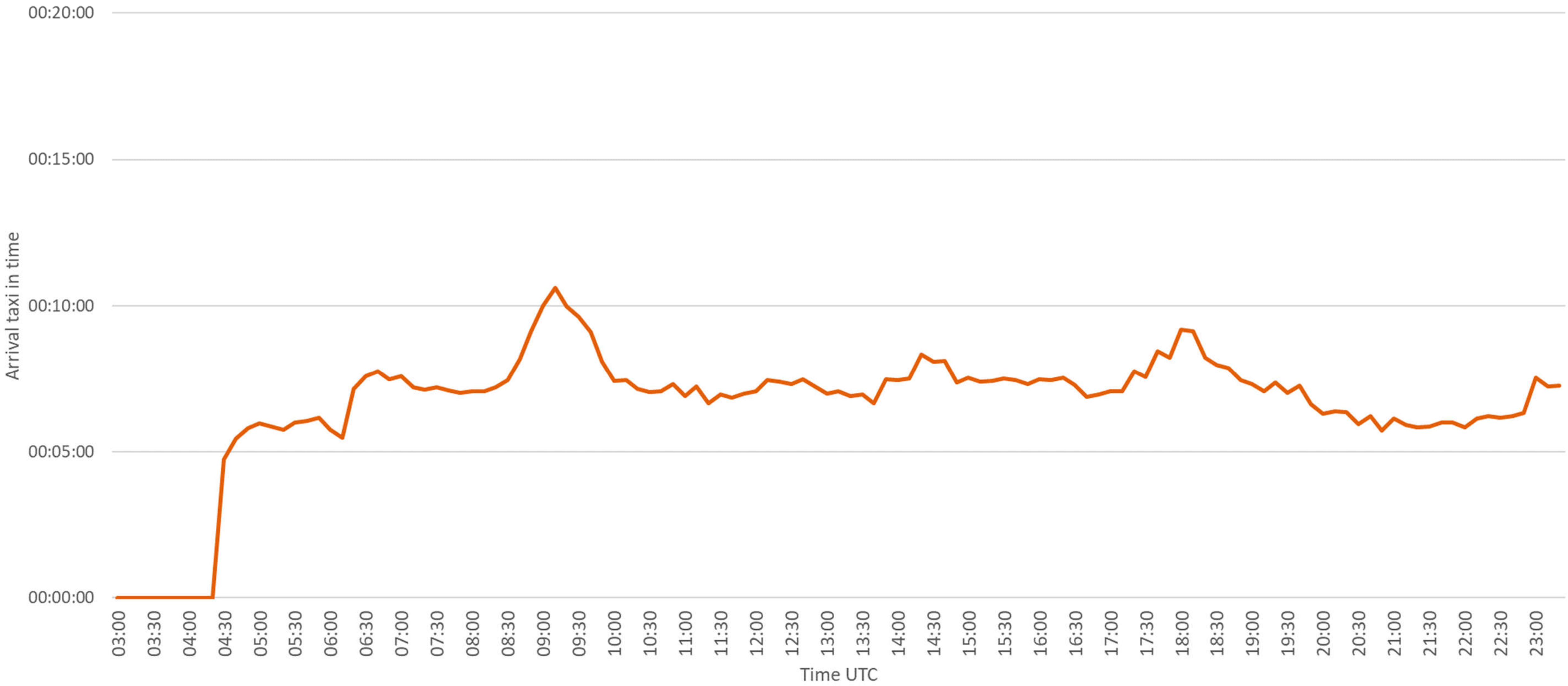
- The model showed very smooth flows of traffic to/from either runway.
- As a result, there is little delay accumulated on taxiway segments. This delay is most frequently accumulated in areas where there are an increased number of pushbacks (e.g. South Apron or Apron 5G).
- The simulation also indicates that areas with the highest concentration of aircraft stoppings occur on aprons (where pushbacks may complicate flow of other traffic) and areas near runway entries where aircraft move in a queue waiting for departure.

TAXI TIMES

DEPARTURE TAXI OUT TIME

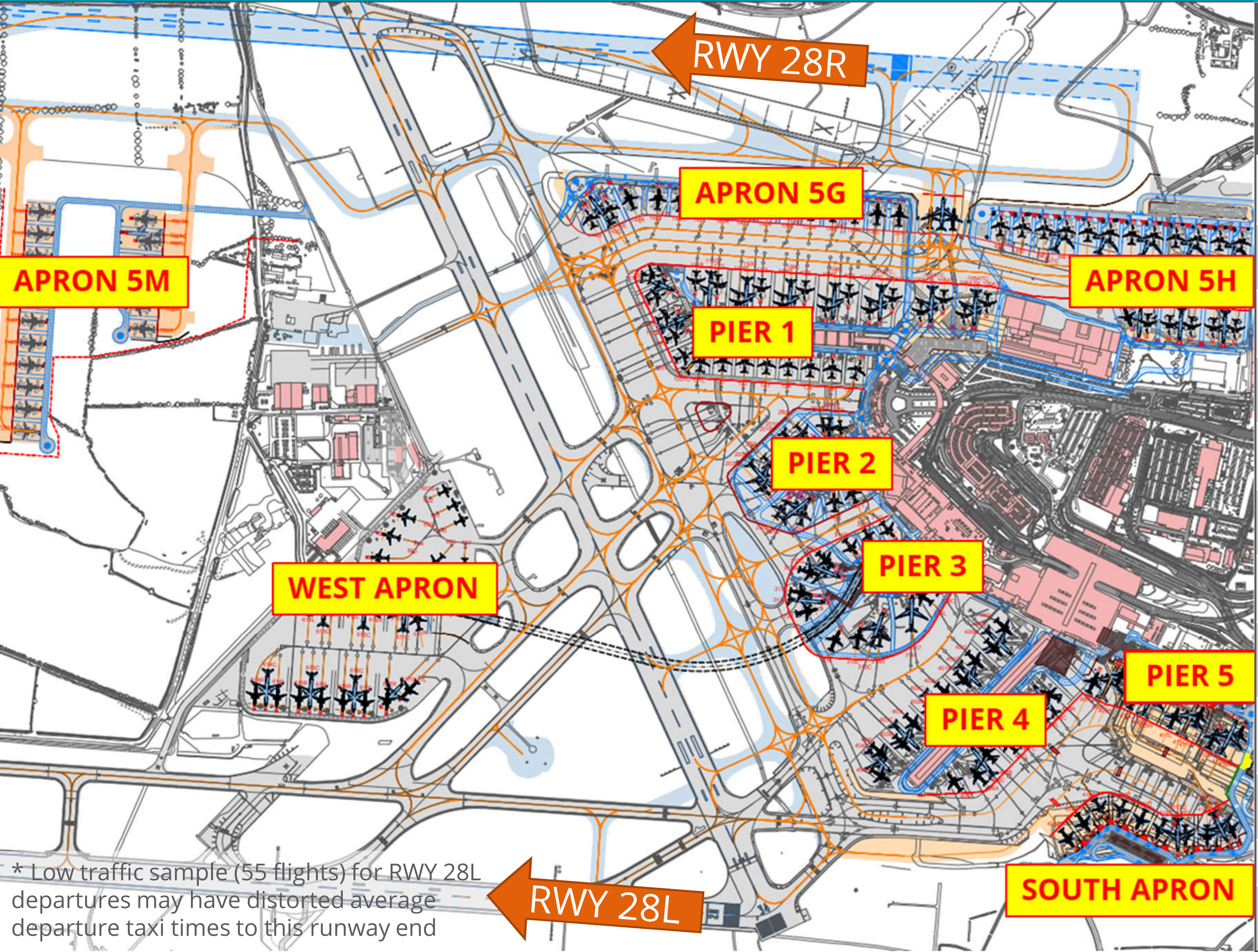


ARRIVAL TAXI IN TIME



* RWY 28L served 100% of arrivals in the simulation

AVERAGE TAXI TIMES BY PIER



* Low traffic sample (55 flights) for RWY 28L departures may have distorted average departure taxi times to this runway end

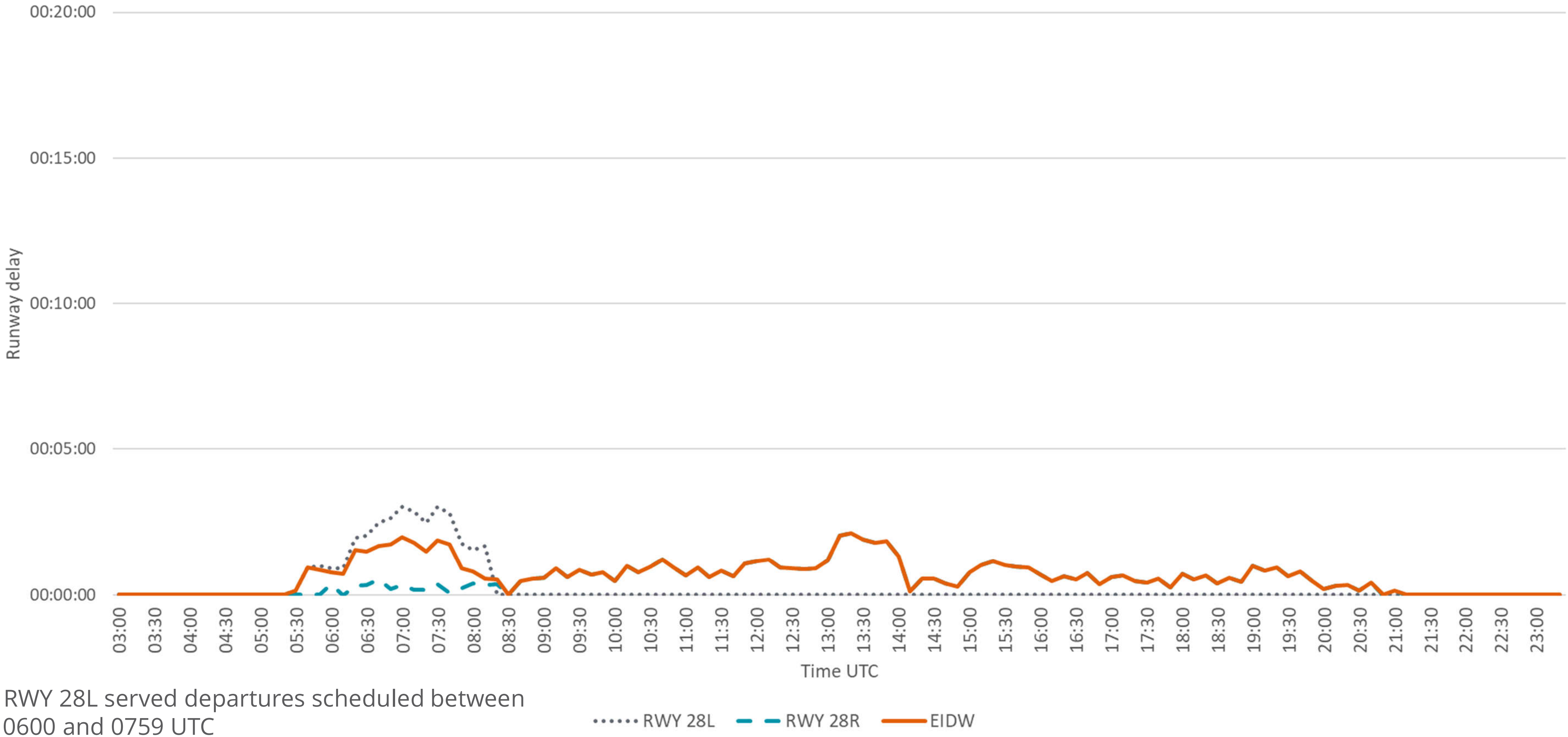
Area	Average taxi out time			Average taxi in time (from RWY 28L)
	Airport-wide	To RWY 28R only	To RWY 28L only	
APRON 5G	00:09:10	00:08:33	00:13:58	00:06:11
APRON 5H	00:10:43	00:08:04	00:13:22	00:11:45
PIER 1	00:09:38	00:09:34	00:10:43	00:07:59
PIER 2	00:10:45	00:10:50	00:09:48	00:06:36
PIER 3	00:12:01	00:12:25	00:08:23	00:07:34
PIER 4	00:13:25	00:13:58	00:08:51	00:07:42
PIER 5	00:16:36	00:17:13	00:11:05	00:08:41
SOUTH APRON	00:11:39	00:14:06	00:08:34	00:08:20
WEST APRON	00:11:03	00:11:03	-	00:04:58
APRON 5M	-	-	-	00:09:21
Average	**00:11:03**	**00:11:06**	**00:10:32**	**00:07:38**

TAXI TIMES: OBSERVATIONS

- Despite significantly more flights being proposed in the CIP flight schedule modelled (compared to current traffic levels), the model showed major improvement (decrease) in departure taxi out times compared to existing airfield layout, regardless of which runway the aircraft were taxiing to. This can be attributed mostly to the dual parallel taxiway leading all the way from the Pier 4 / South Apron to the Pier 1 / Apron 5G, allowing parallel operations of aircraft up to Code E size.
- Peak taxi out times simulated for both runway ends and measured across the airport as a whole never exceeded 15 minutes.
- Average taxi out time for RWY 28L was between 10-11 minutes while
- Average taxi out time for RWY 28R was just above 11 minutes.
- Performance of arrival taxi in time metric remained similar to performance observed under the existing airfield layout. This result can be primarily attributed to the operating mode modelled, where all arrival traffic used RWY 28L in the same way as it is being used today.
- Average taxi in time for arrivals on RWY 28L was between 7 and 8 minutes.

RUNWAY DELAY

DEPARTURE RUNWAY DELAY BY RUNWAY



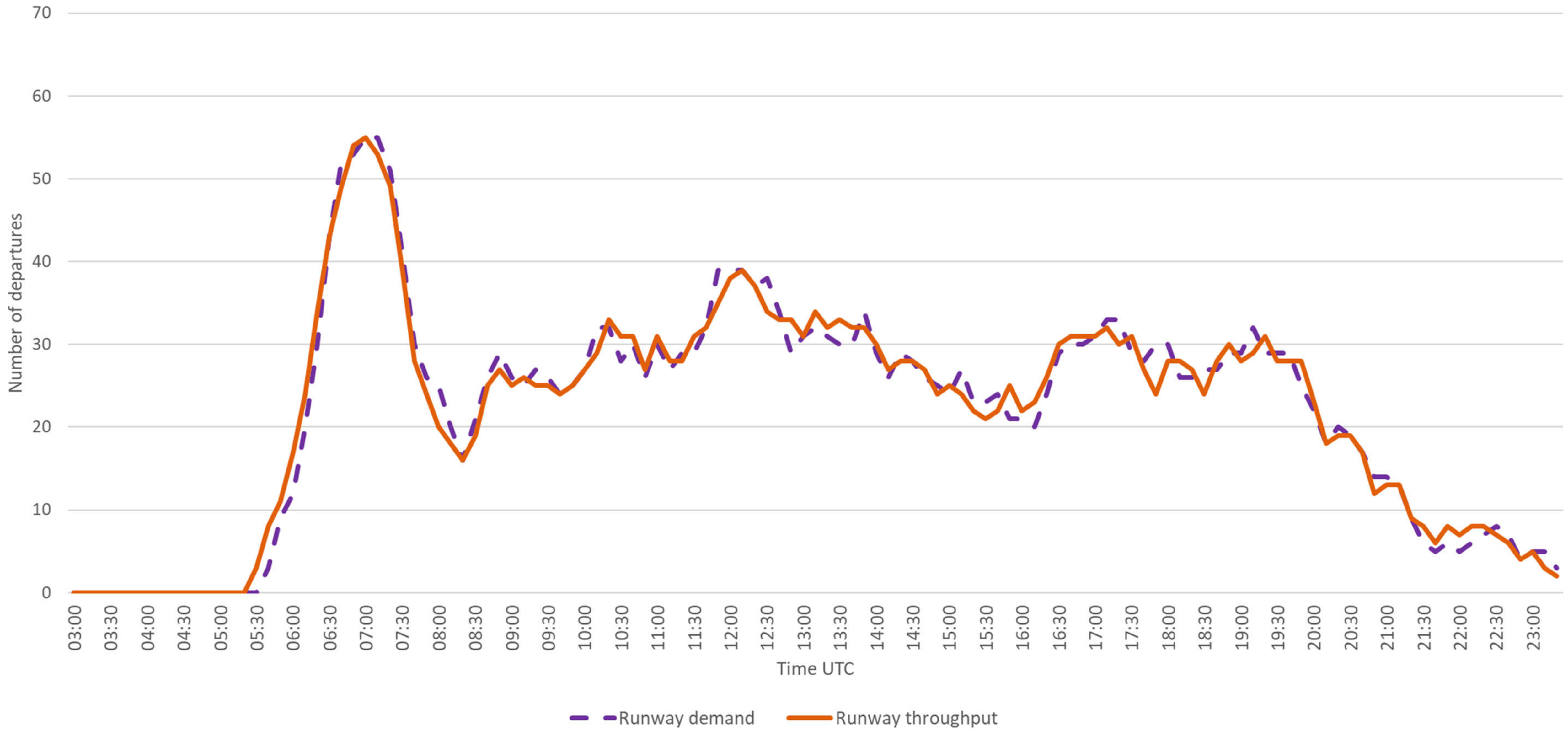
* RWY 28L served departures scheduled between 0600 and 0759 UTC

DEPARTURE RUNWAY DELAY: OBSERVATIONS

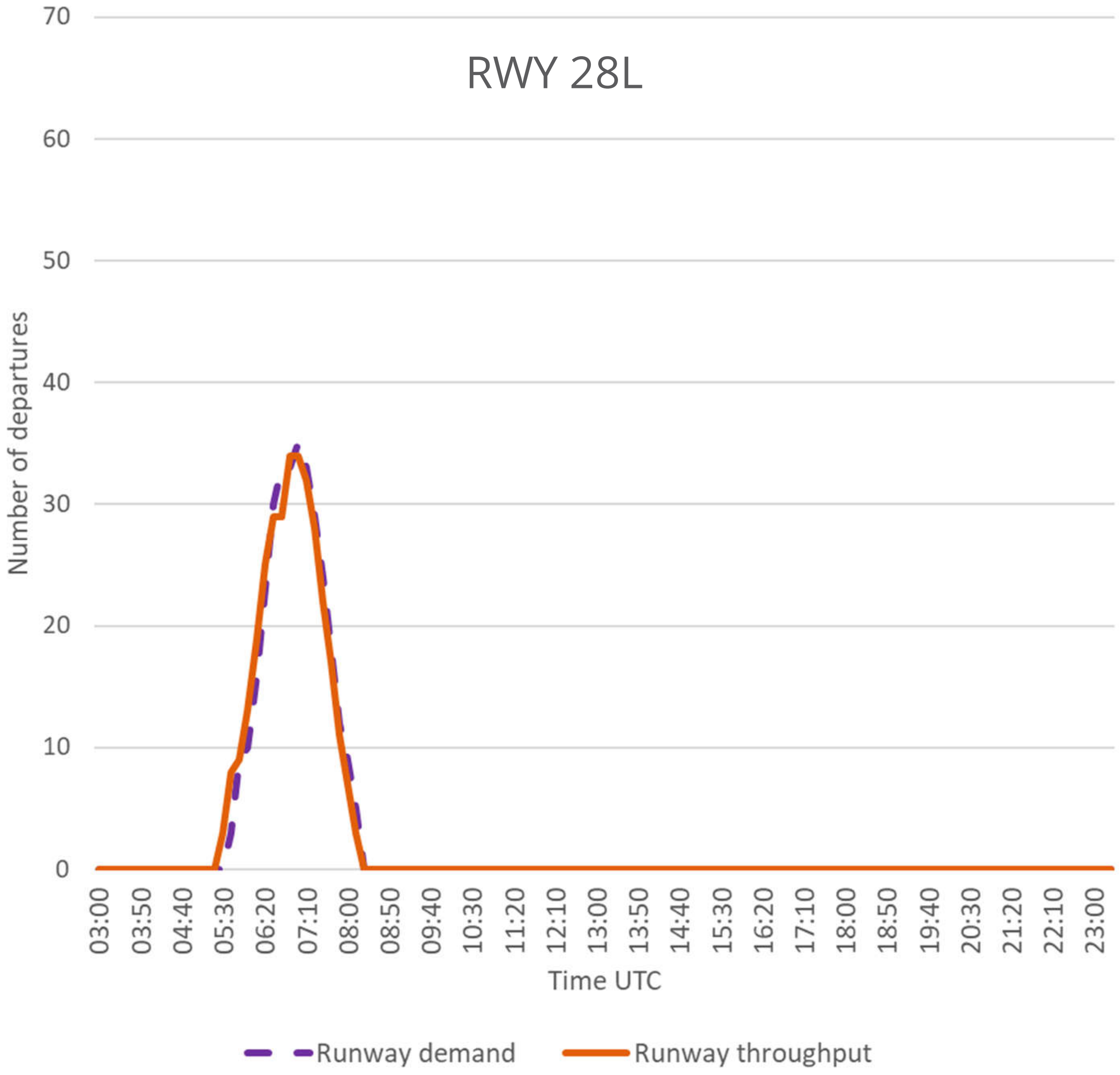
- Simulated departure runway delay was considerably lower compared to current (W19) levels.
- Average departure runway delay measured across the whole airport (on both runways combined) over the whole day was less than a minute.
- Peak departure runway delay was 2 minutes for the airport as a whole.
- Peak runway delay was 3 and 2 minutes for RWY 28L and RWY 28R respectively.
- The split of runways used during the mixed mode period was 60% and 40% for RWY 28L and RWY 28R respectively. This split was mainly driven by the requirement to depart to either north or south sector.

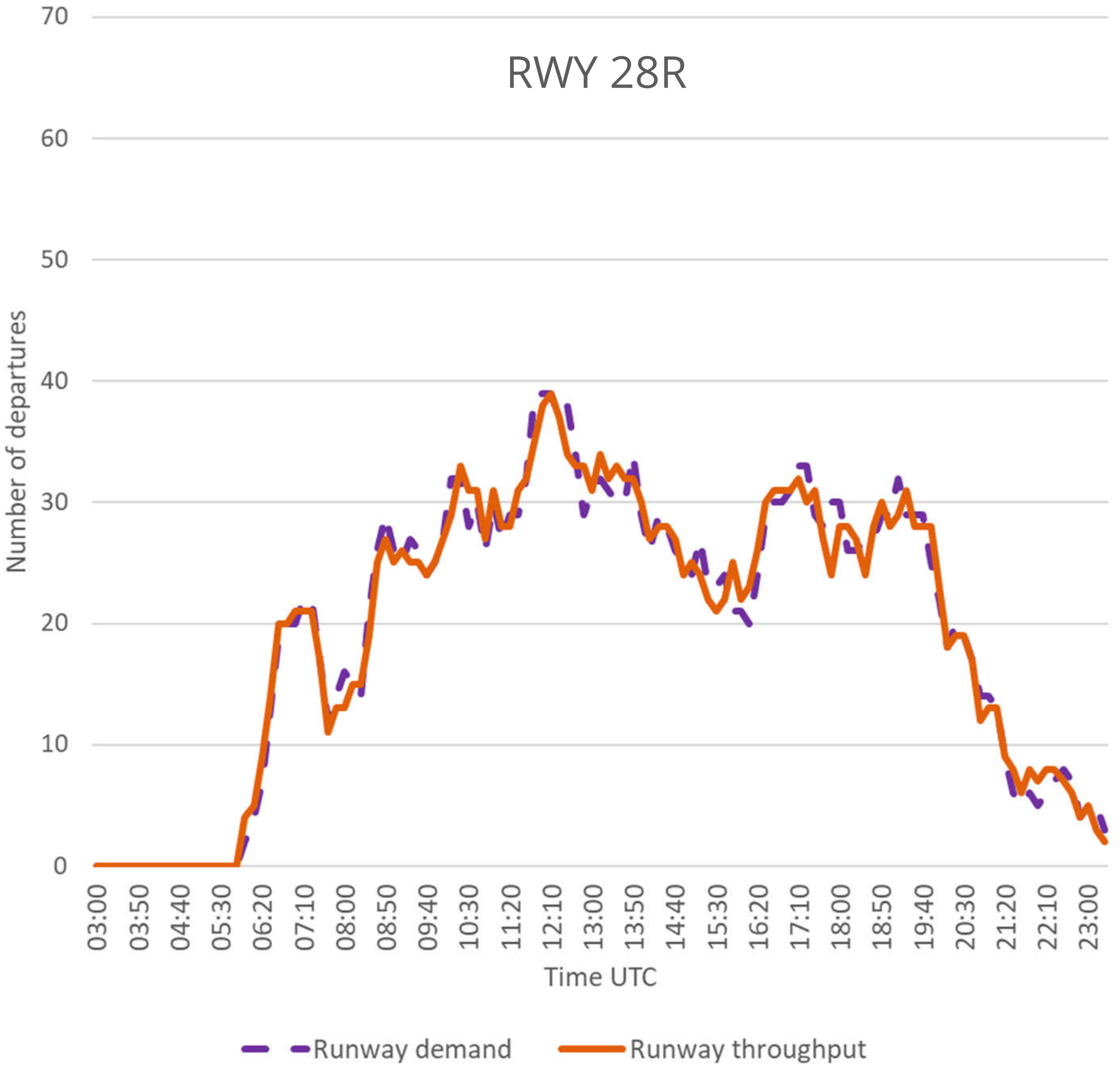
RUNWAY THROUGHPUT

DEPARTURE RUNWAY THROUGHPUT: BOTH RUNWAYS COMBINED

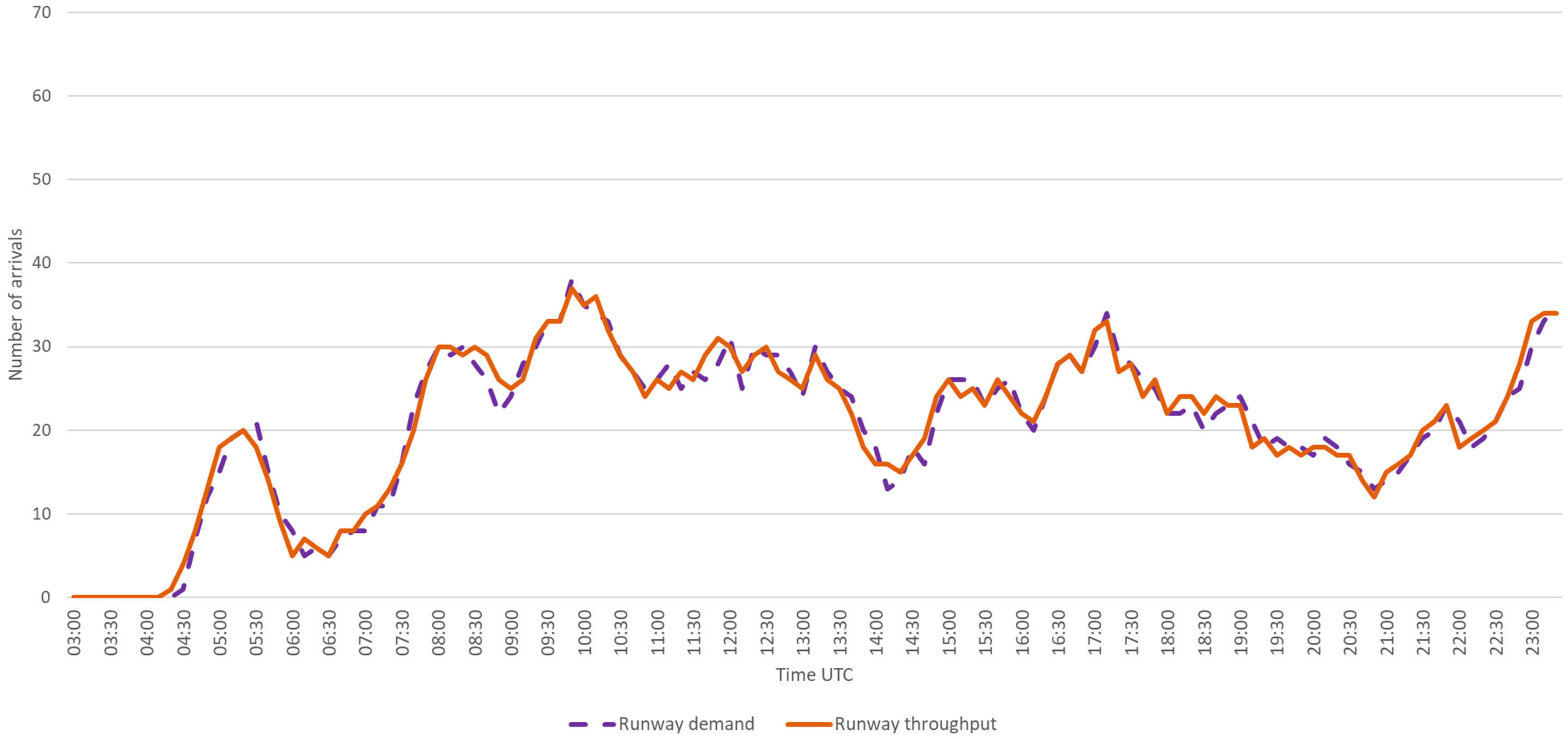


DEPARTURE RUNWAY THROUGHPUT BY RUNWAY

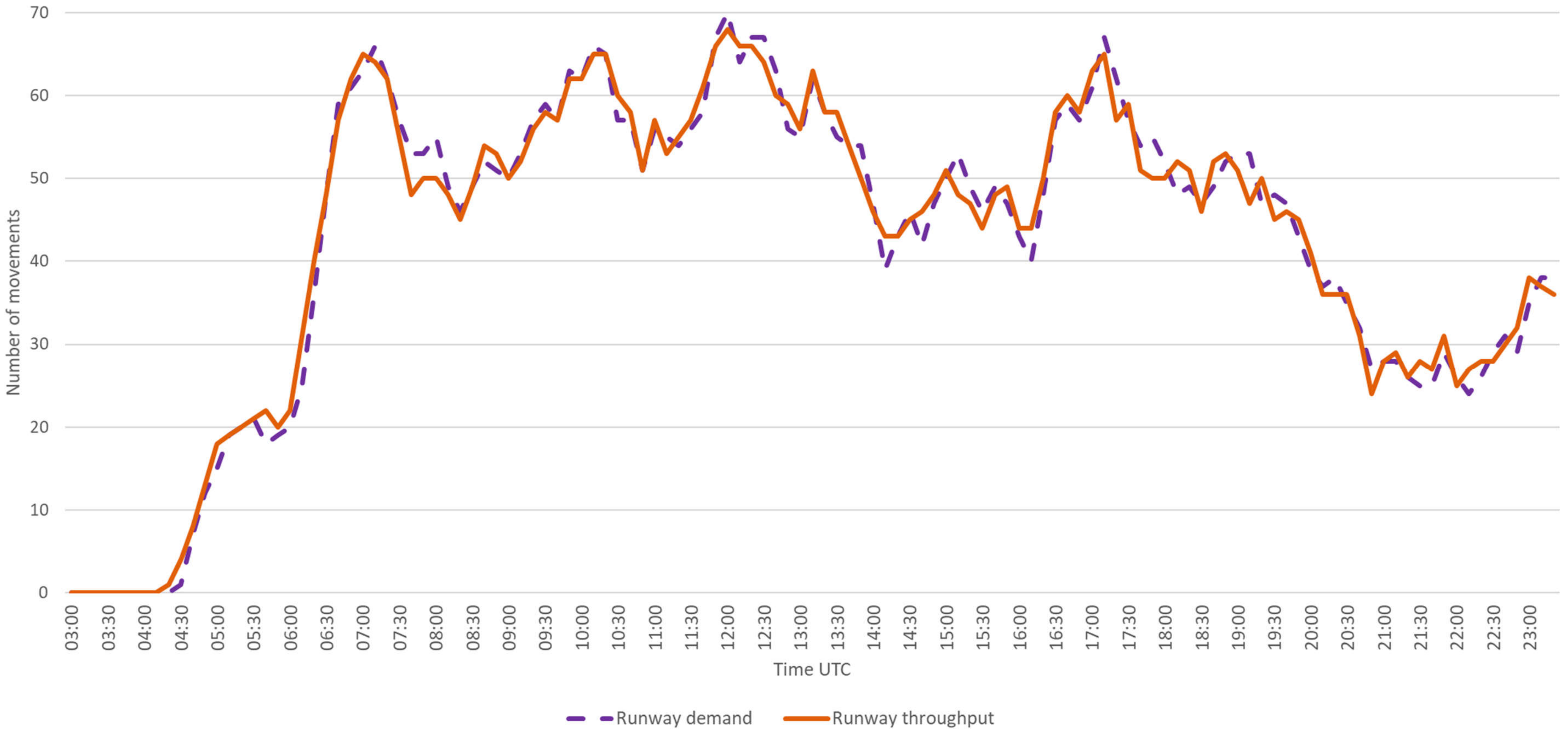




ARRIVAL RUNWAY THROUGHPUT: RWY 28L



TOTAL RUNWAY THROUGHPUT: BOTH RUNWAYS COMBINED



RUNWAY THROUGHPUT: OBSERVATIONS

- The peak runway demand and throughput observed in the simulation are presented below.

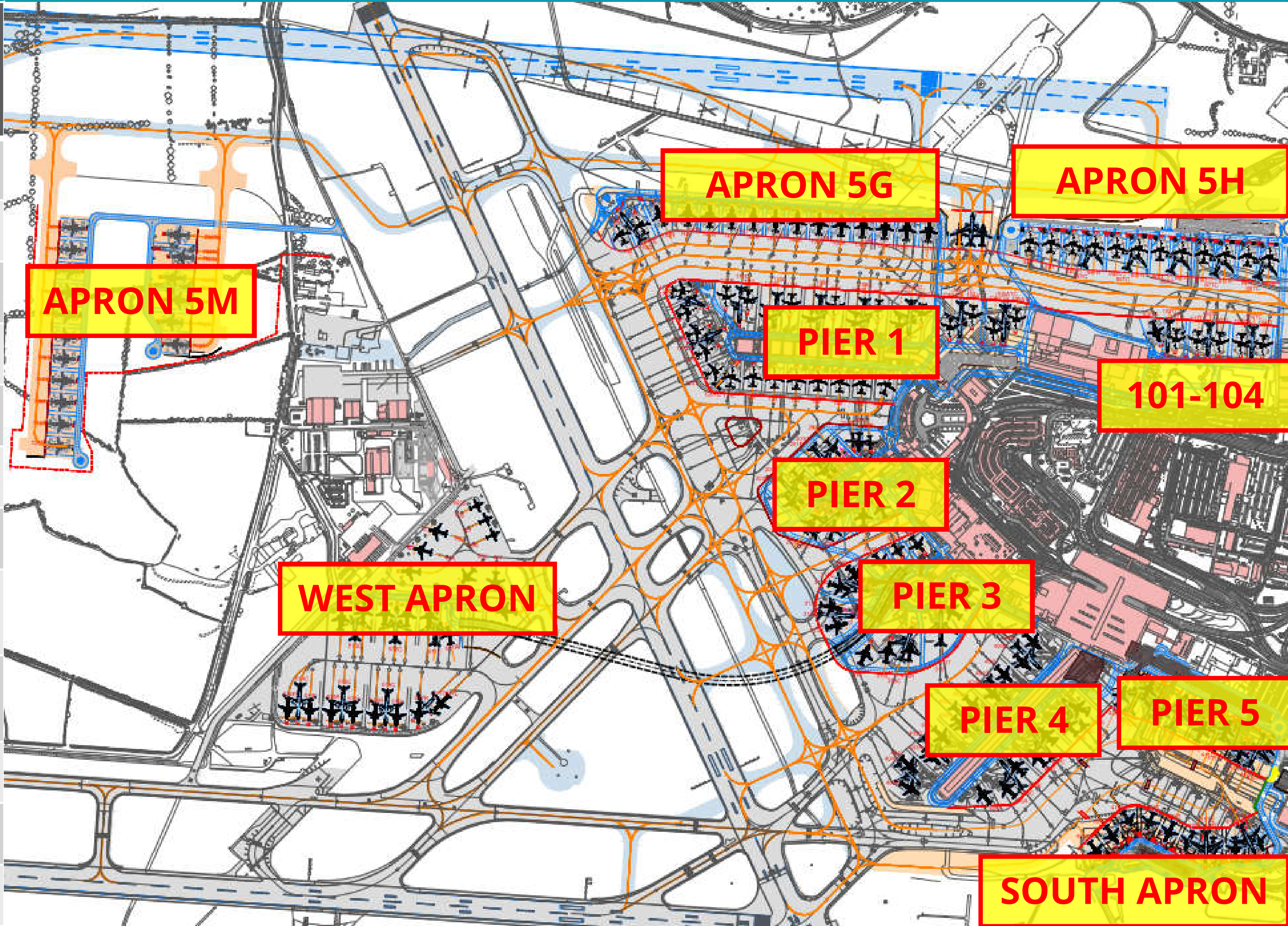
	RWY 28L departures	RWY 28R departures	RWY 28L arrivals
Peak demand	35	39	38
Peak throughput	34	39	37

- Maximum combined throughput observed in the simulation was 68 movements per hour (30 arrivals on RWY 28L and 38 departures from RWY 28R).
- As there are no major differences between the demand curve and throughput curve it can be concluded both runways will be able to cope with the expected demand in a timely fashion.
- The throughput observed through the simulation depends on many variables and should not be interpreted as the ultimate runway capacity.

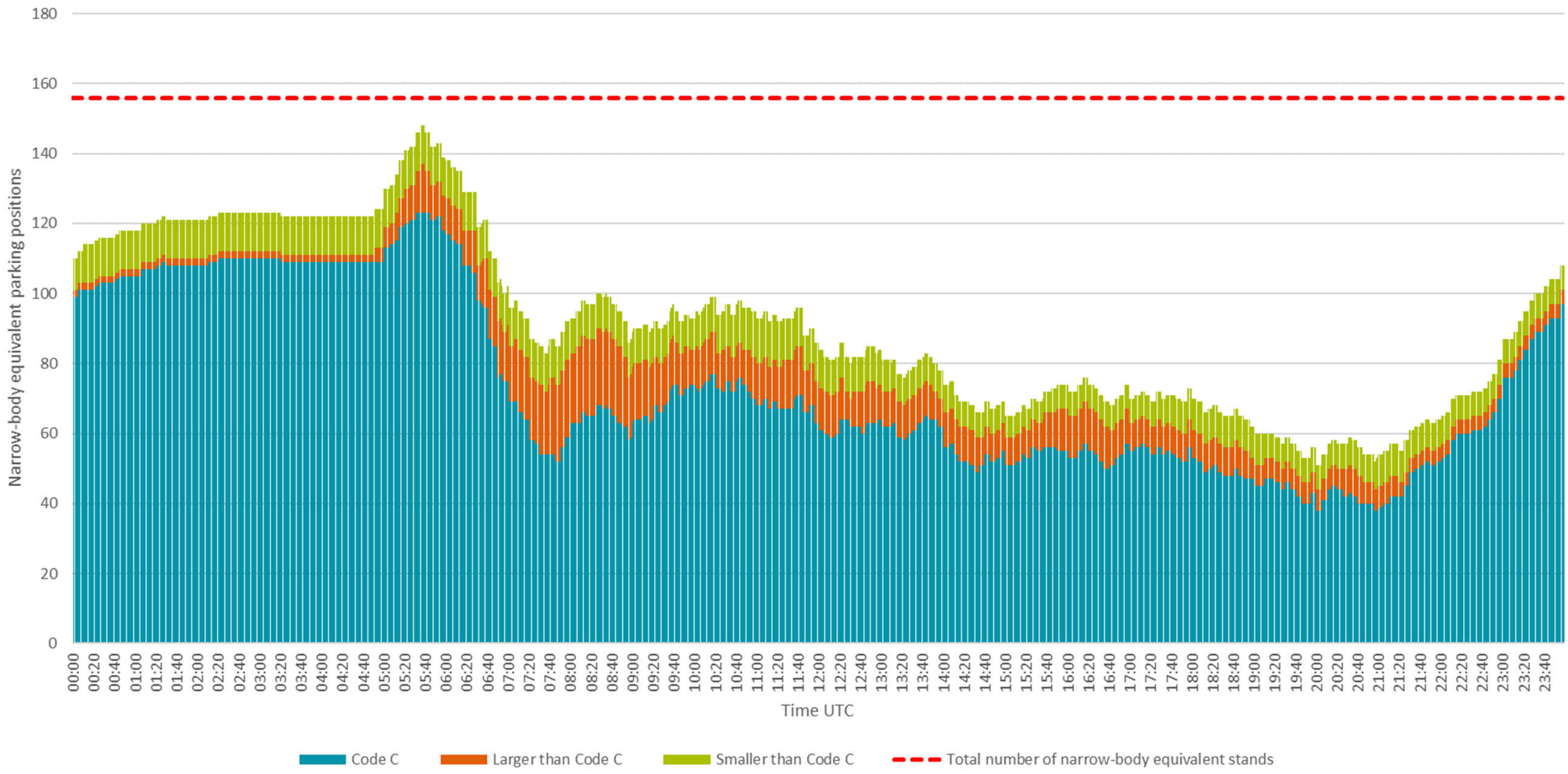
STAND DEMAND

STAND DEMAND: AIRPORT LAYOUT

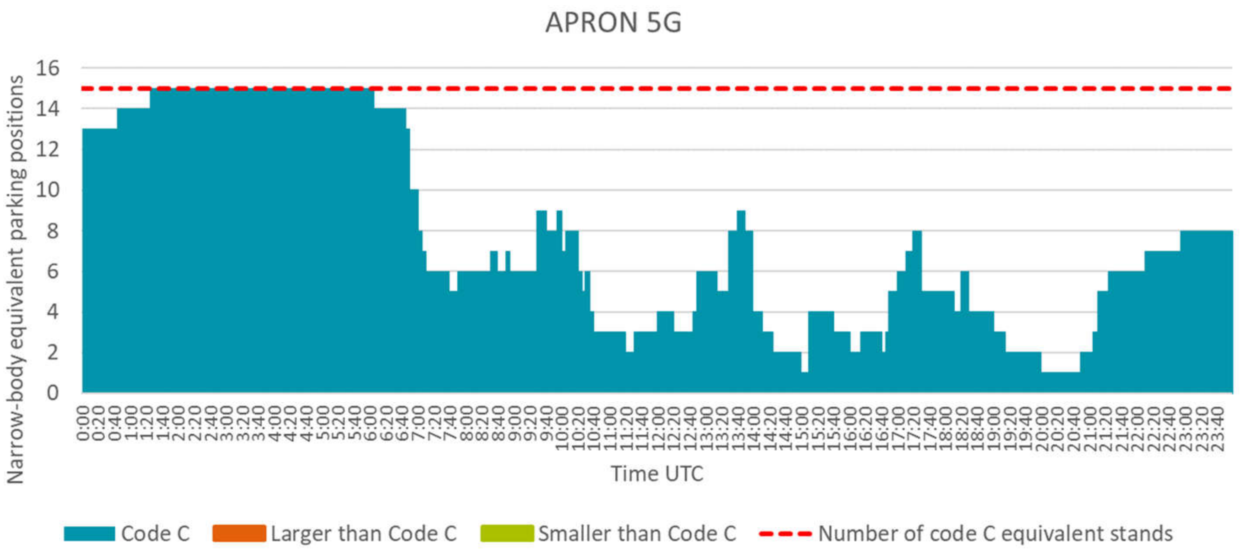
Area	Narrow-body parking positions	Wide-body parking positions
APRON 5H	12	5
APRON 5G	15	1
PIER 1	27	10
PIER 2	10	3
PIER 3	12	5
PIER 4	17	8
PIER 5	8	4
SOUTH APRON	9	2
WEST APRON	23	7
APRON 5M	17	2
STANDS 101-104	6	3
TOTAL	**156**	**49**

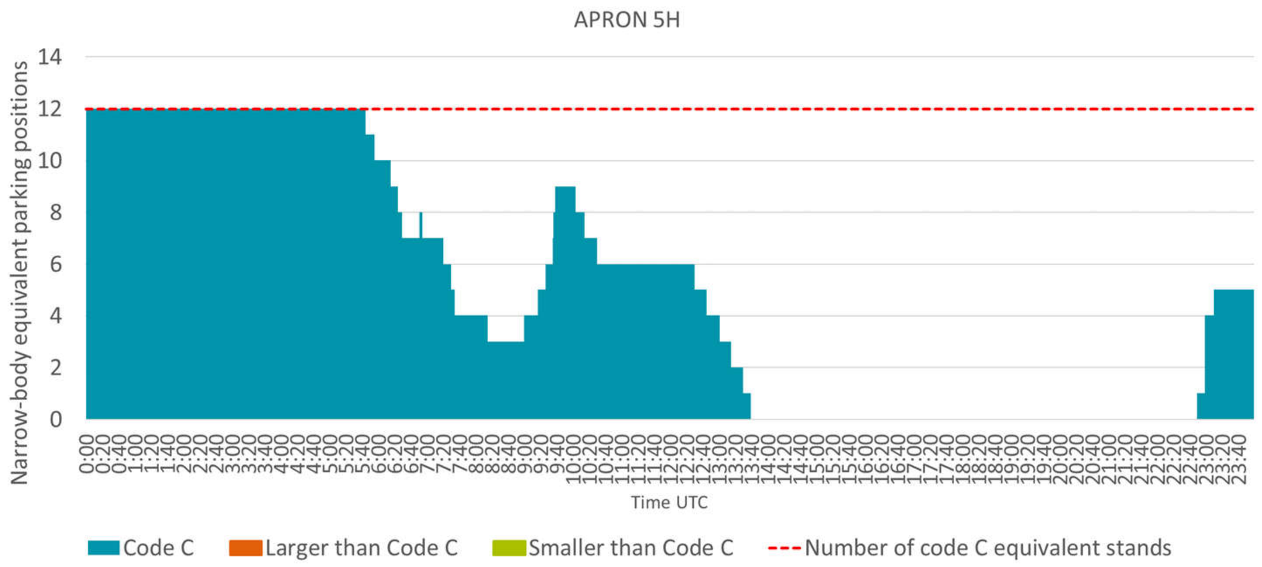


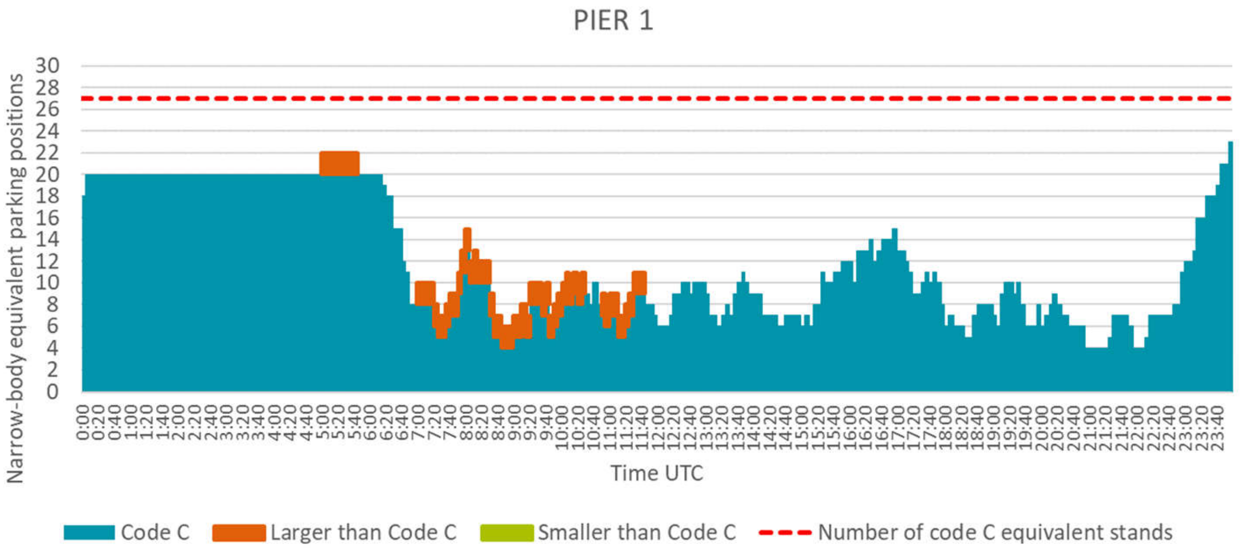
STAND DEMAND BY AIRCRAFT SIZE: NUMBER OF NARROW-BODY EQUIVALENT PARKING POSITIONS OCCUPIED DURING THE DESIGN DAY (AT AIRPORT LEVEL)

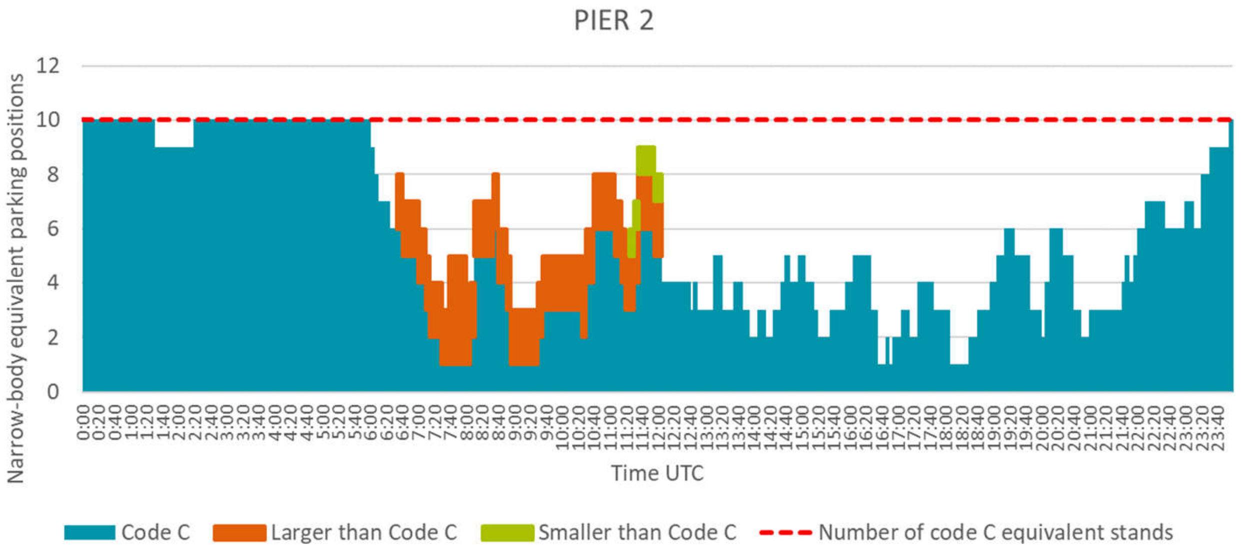


STAND DEMAND BY AIRCRAFT SIZE: BY APRON/PIER









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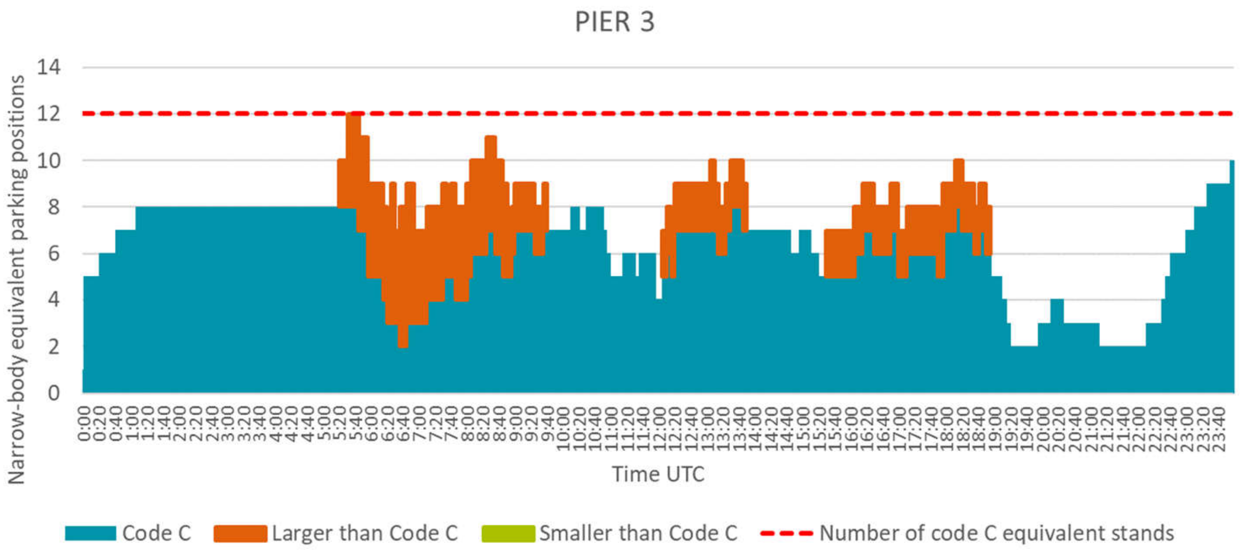
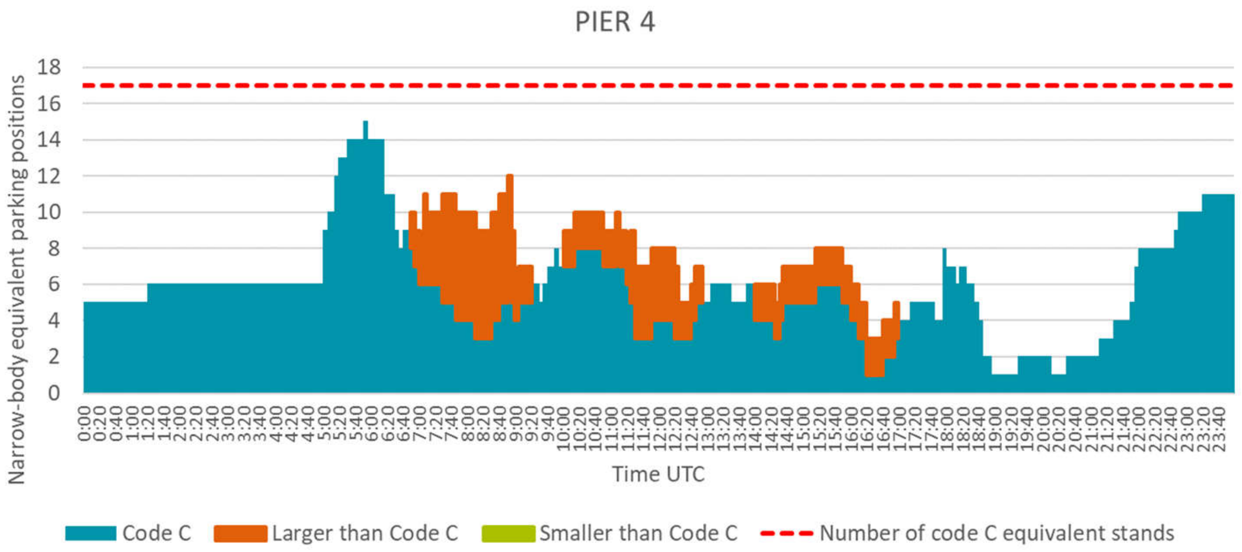
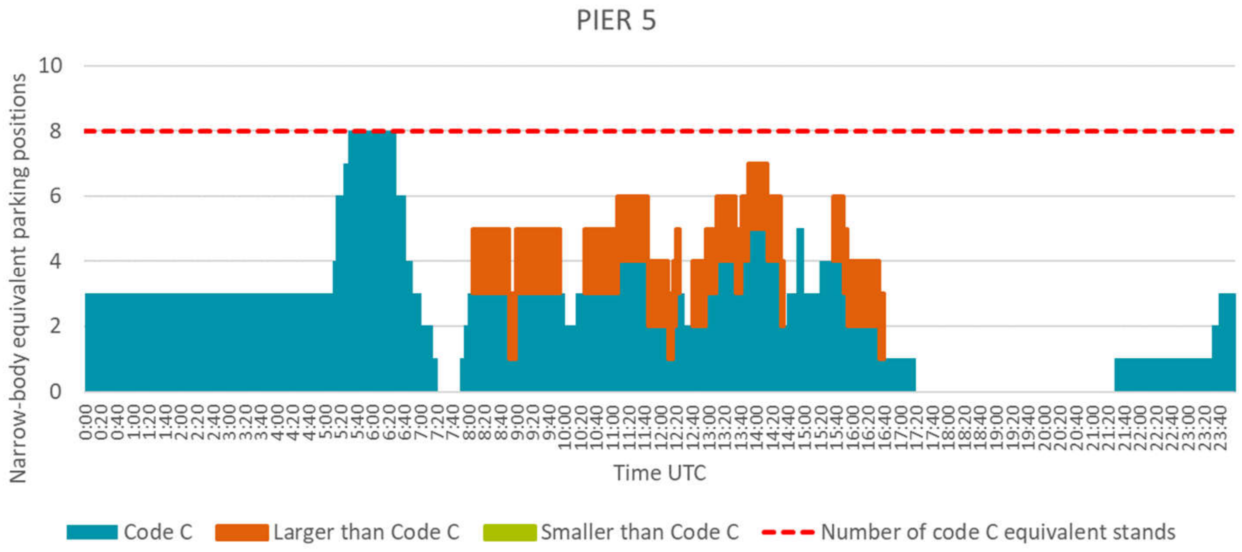
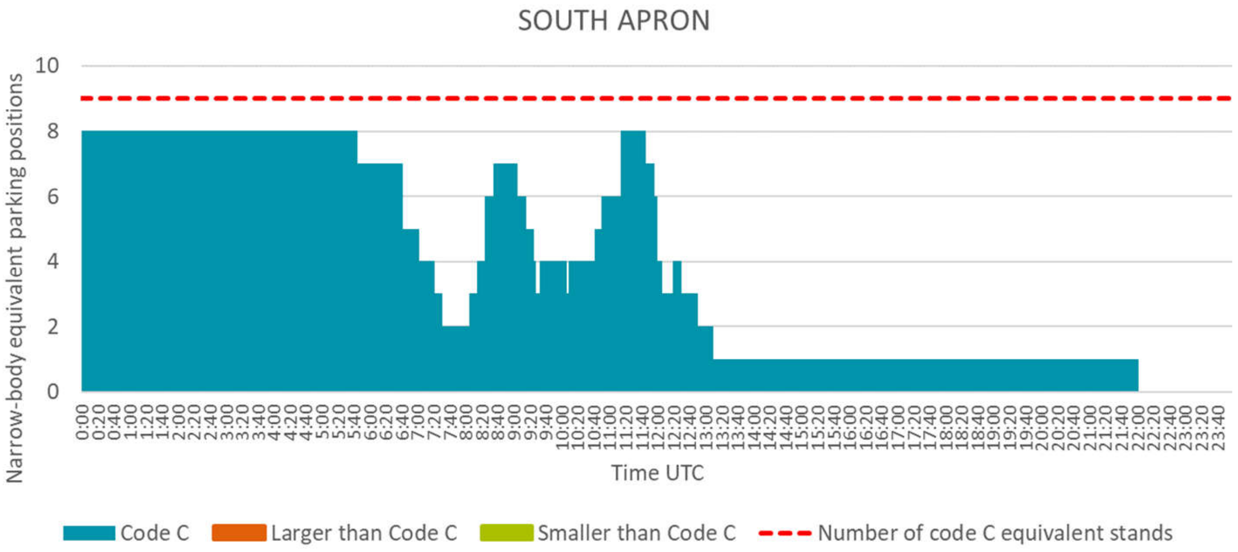
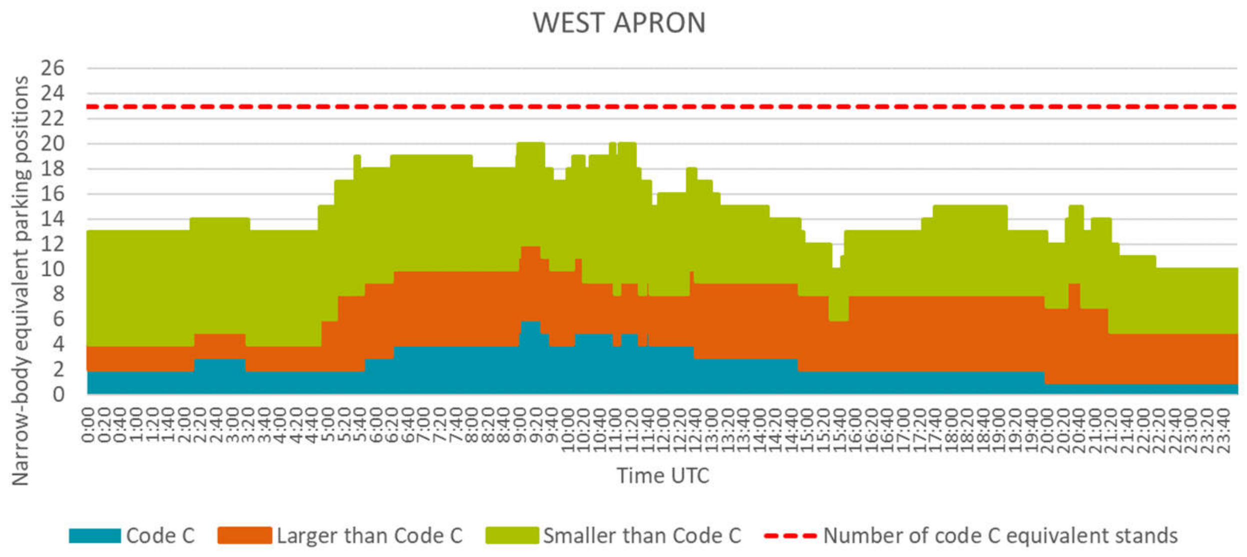


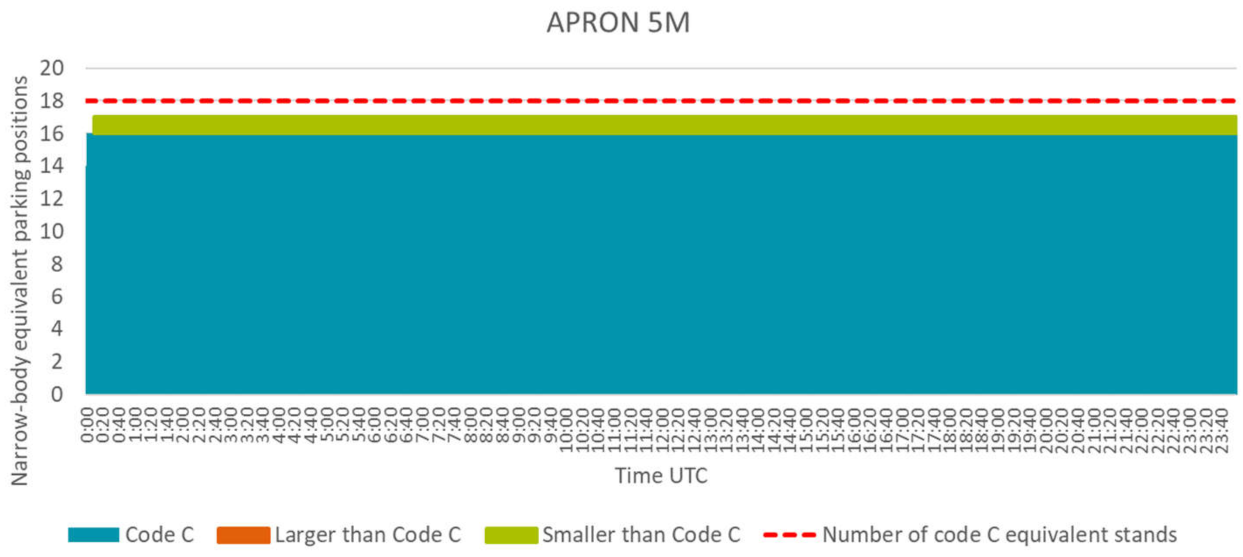


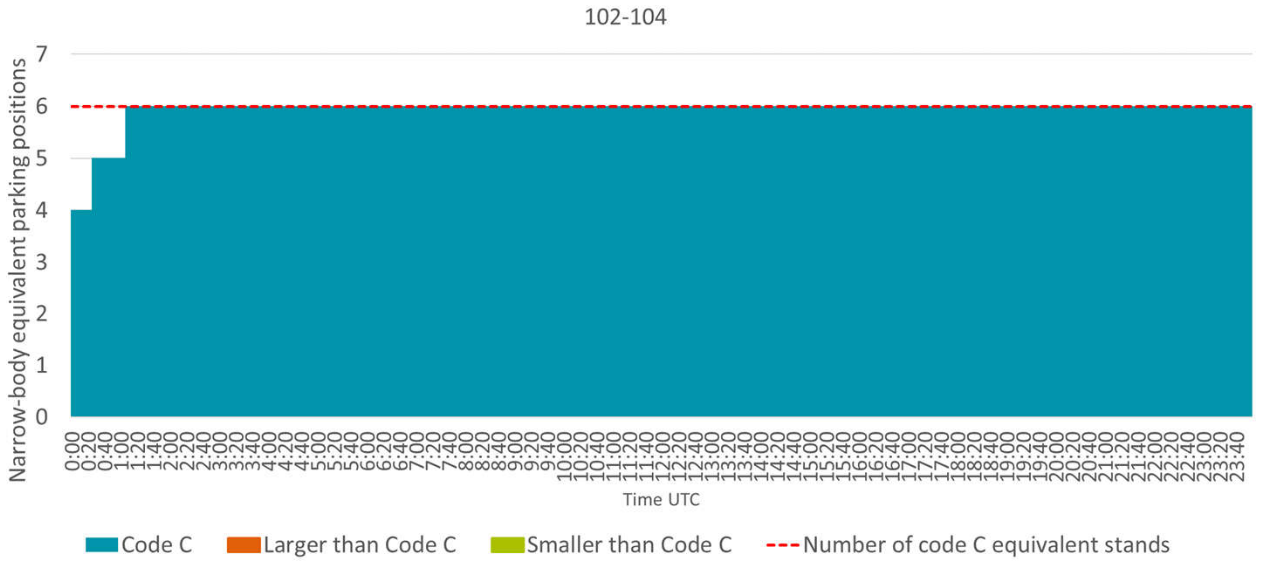




STAND DEMAND BY AIRCRAFT SIZE: BY APRON/PIER







STAND DEMAND: OBSERVATIONS

- Stand demand is driven primarily by Code C aircraft.
- Peak stand demand is at 0545 UTC and is caused by:
  - aircraft staying overnight which have not yet left by 0545, and
  - early morning arrivals which have arrived before 0545.
- After the morning peak, the stand demand gradually decreases until 2100 when the first Dublin-based aircraft start coming back to Dublin for their overnight stay.
- Proposed CIP projects help alleviate existing stand demand problems.
- Apron 5M and West Apron can be used for long term parking, with the West Apron serving also the general aviation flights.

LIST OF ACRONYMS AND ABBREVIATIONS

A-A	Arrival-Arrival separation	**ICAO**	International Civil Aviation Organisation
A-D-A	Departure-Arrival-Departure separation	**kts**	Knots
CAD drawing	Computer-Aided Design drawing	**MARS**	Multi Aircraft Ramp System
CAR	Commission for Aviation Regulation	**NM**	Nautical Mile
CIP	Capex Investment Programme	**RWY**	Runway
daa	Dublin Airport Authority	**SID**	Standard Instrument Departure route
D-D	Departure-Departure separation	**STAR**	Standard Terminal Arrival route
IAA	Irish Aviation Authority – Air Navigation Service Provider	**UTC**	Universal Time Coordinated
IATA	International Air Transport Association	**W19**	Winter 2019 season

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