

Introduction

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Introduction



DataScience@SMU

Crew Scheduling Business Problem

Balancing Resources and Cost

Definitions

Crew Scheduling

- Flight Ops vs. Inflight (FO v. IF)

Open Time Trip (OT or OTT)

Reserve

Open Time Bidder

- Straight vs. Premium

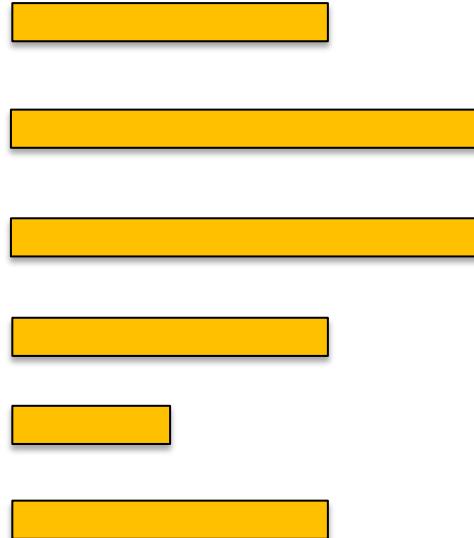
Context

The Crew Scheduling Dept. must make Open Time assignment decisions for the following day without knowledge of the availability of Reserves or amount of Open Time Trips to be covered.

Business Problem



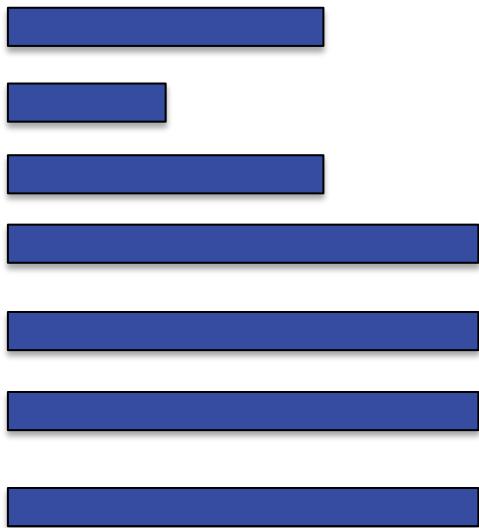
Open Time Trips



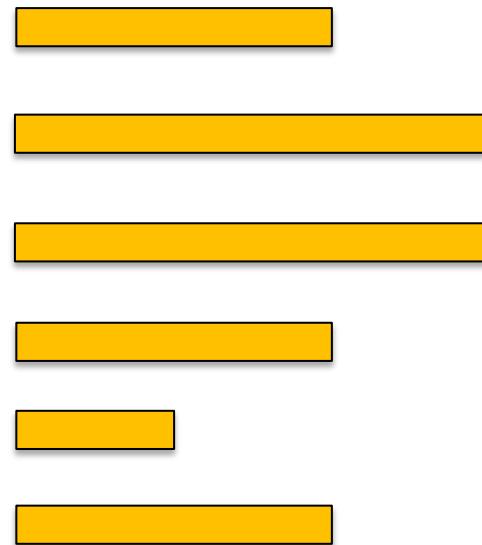
Business Problem



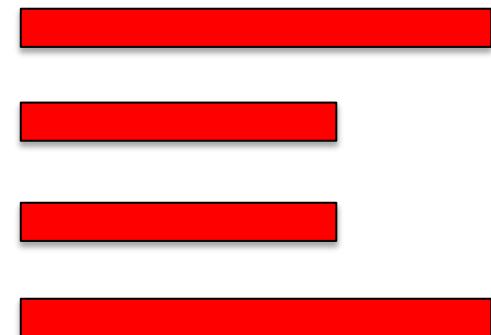
Reserves



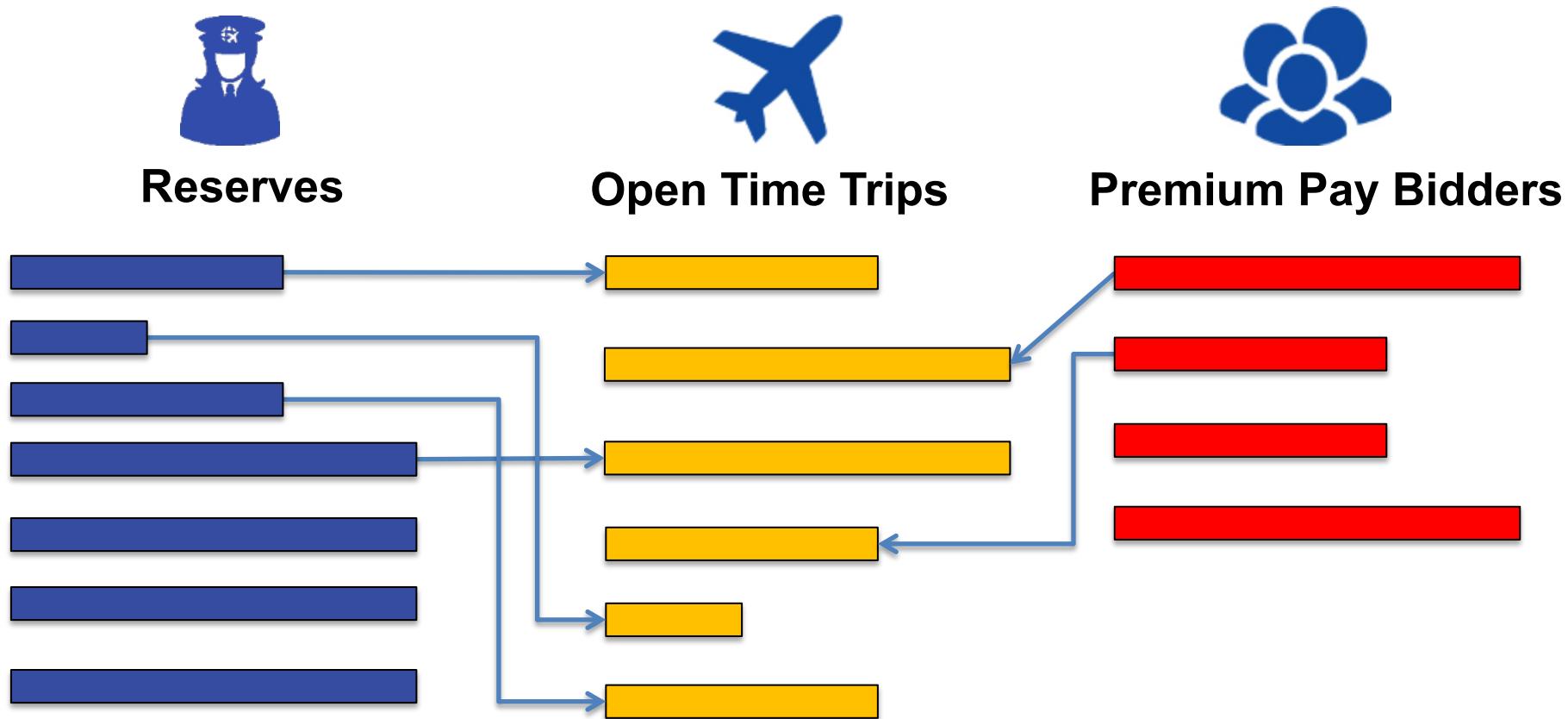
Open Time Trips



Premium Pay Bidders



Business Problem



Business Problem



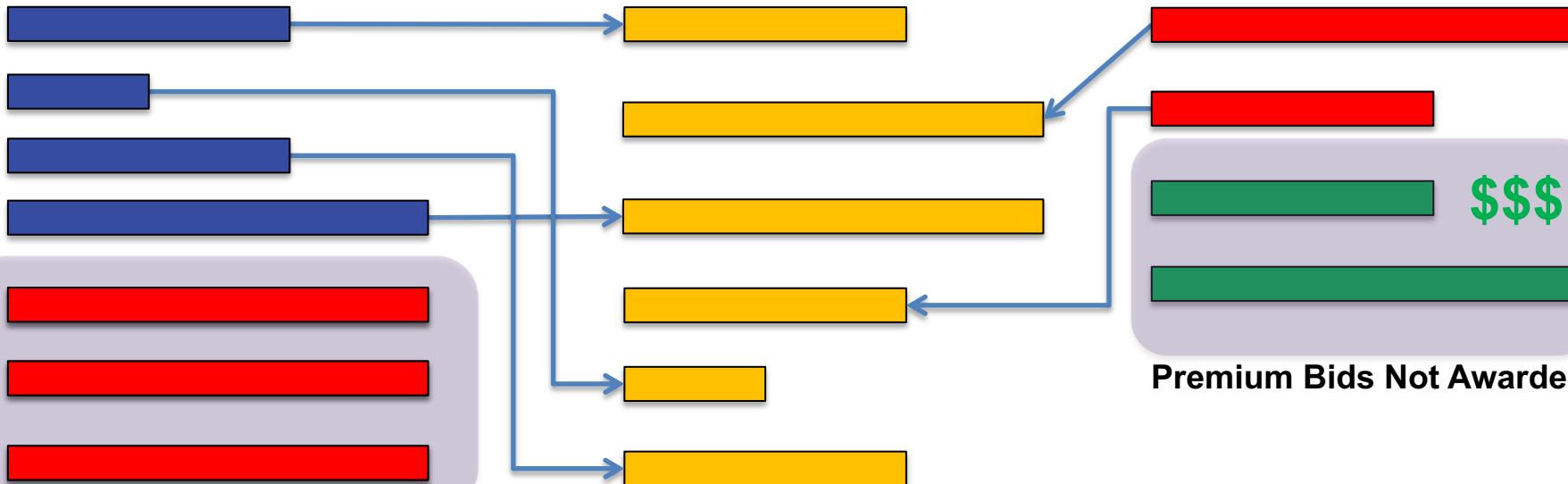
Reserves



Open Time Trips



Premium Pay Bidders

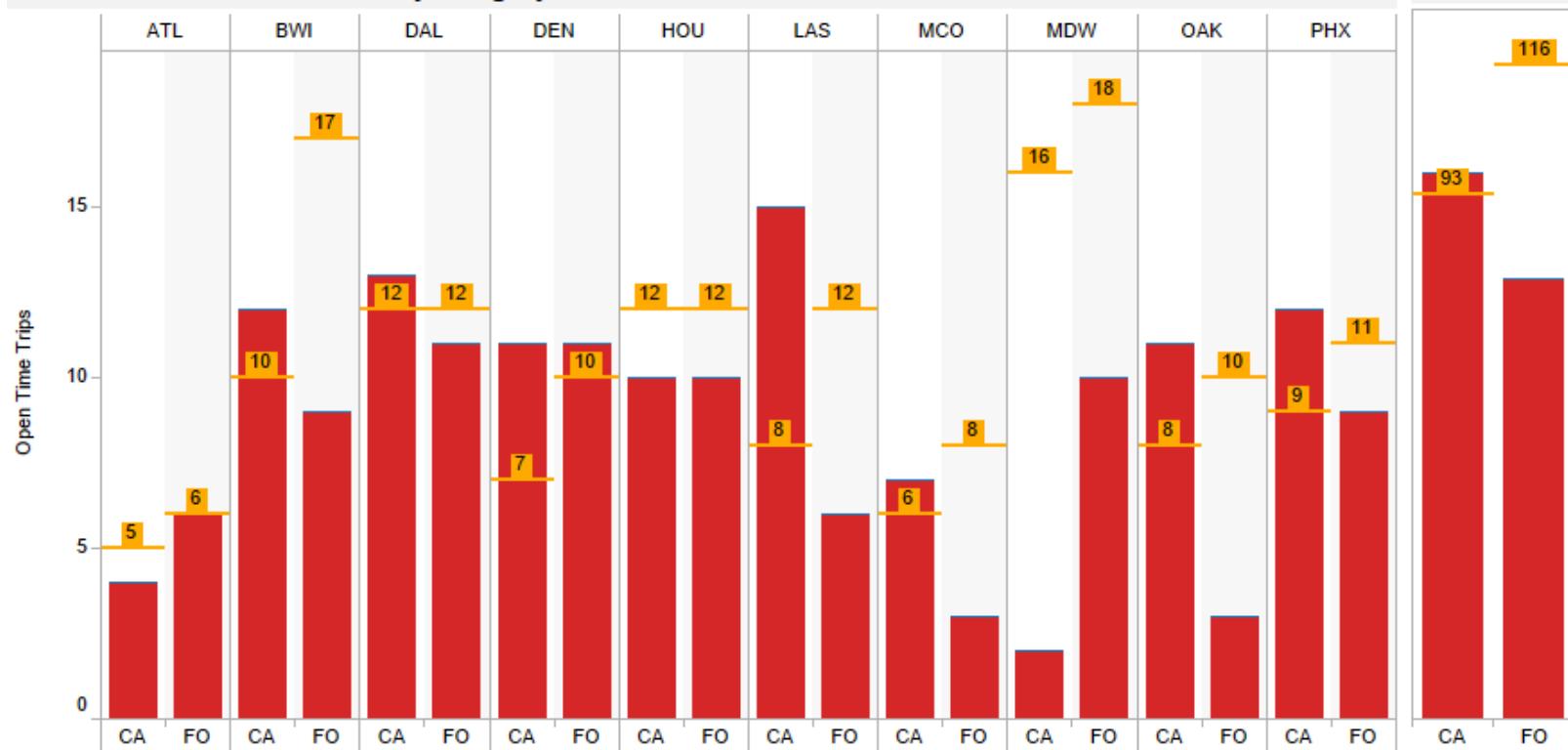


Insurance Reserves Held Out

Time-lapse

FO Open Time Decision Tool
0600 April 19 – End of Day April 20

Total OT Forecast vs OT Actual by Category



6:02 am

Base
AllSeat
All

Legend

- RSV_CURRENT
- OT_ASSIGNED
- OT_CURRENT
- OT_FORECAST

FCST																<---- Forecast vs Actual	
OTA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OT	4	6	12	9	13	11	11	11	10	10	15	6	7	3	2	10	11

Open Time vs Available Reserves (AM/PM)

OT_AM	3	3	6	8	7	7	3	5	4	8	5	1	4	1	1	5	5
R_AM	3	3	5	10	5	7	5	5	7	6	4	6	2	4	8	9	2
OT_PM	1	3	6	1	6	4	8	6	6	2	10	5	3	2	1	5	6
R_PM	2	3	5	7	7	5	2	5	5	6	4	6	4	4	8	9	6
Total by Seat	43	46															
	44	59															

Notes:
FCST = FORECAST OT
(updates daily)

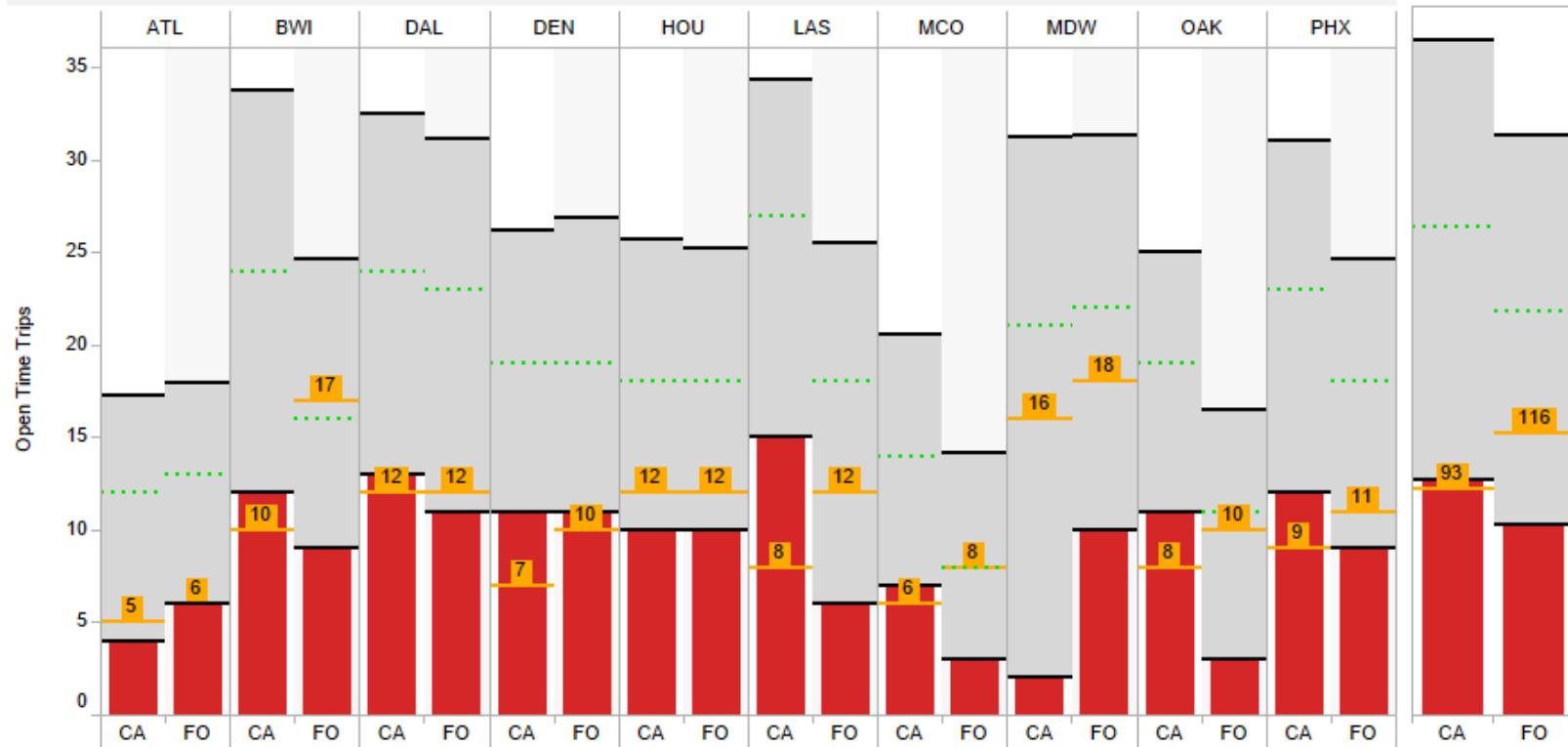
OTA = OT Assign
OT = OT Current
R = Avail Rsv Blk
(updates hourly)

OT Assignments by Label

DOT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PREM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RSV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total by Seat	0	0															

DOT (D,E,F,H)
PREM (P,V,Q,J)
RSV (R,S)

Total OT Forecast vs OT Actual by Category



Total by Seat

7:06 am

Base
All
Seat
All

Legend
█ RSV_CURRENT
█ OT_ASSIGNED
█ OT_CURRENT
█ OT_FORECAST

FCST	12	13	23	16	24	22	18	19	18	17	27	17	13	8	21	21	18	11	22	17	196	160
OTA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OT	4	6	12	9	13	11	11	11	10	10	15	6	7	3	2	10	11	3	12	9	97	78

<---- Forecast
vs Actual

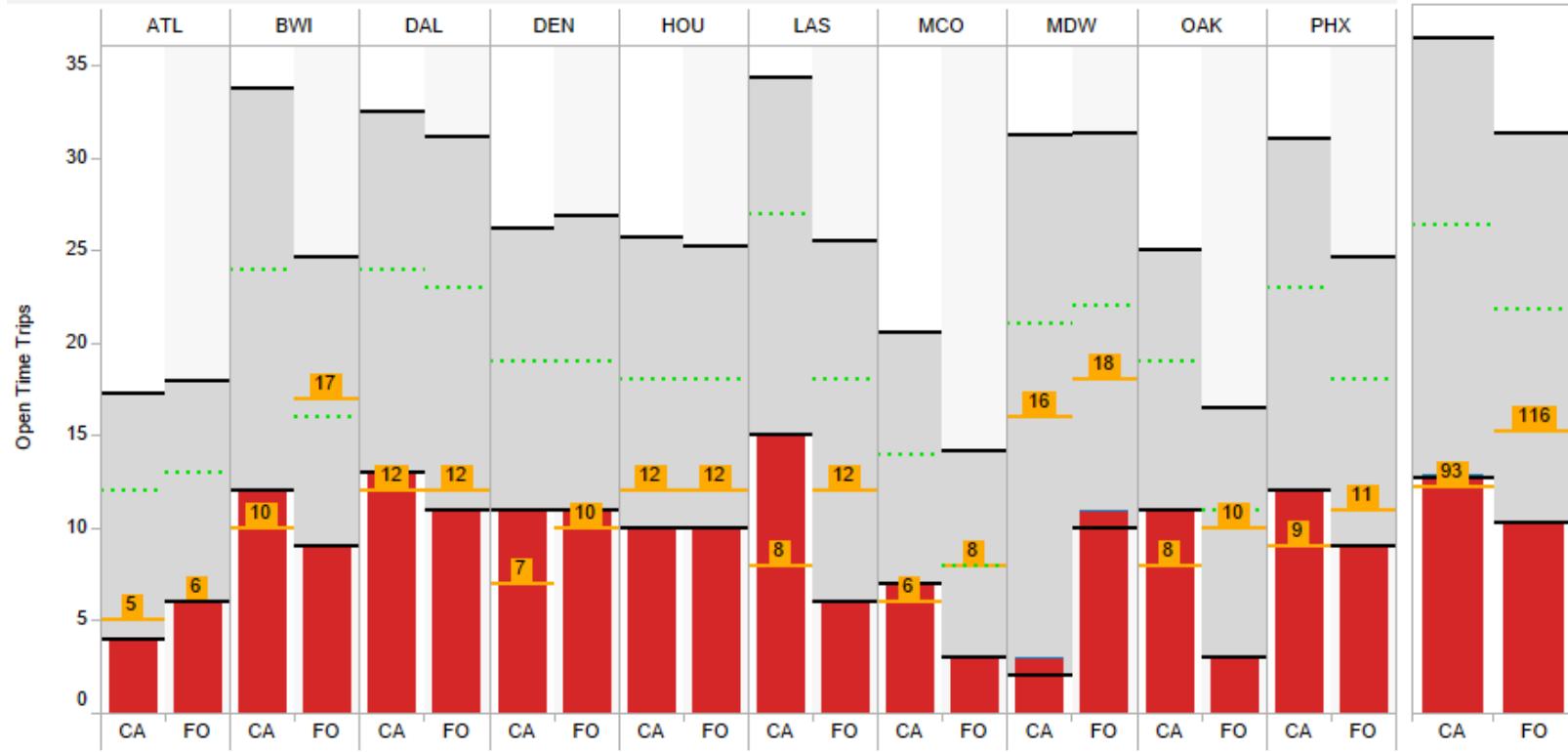
	Open Time vs Available Reserves (AM/PM)																Total by Seat	
OT_AM	3	3	6	8	7	7	3	5	4	8	5	1	4	1	1	5	43	46
R_AM	3	3	5	10	5	7	5	5	7	6	4	6	2	4	8	9	44	59

Notes:
 FCST = FORECAST OT
(updates daily)

	OT_ASSIGNMENT by Label																Total by Seat
DOT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PREM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RSV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

OTES (D,E,F,H)
 PREM (P,V,Q,J)
 RSV (R,S)

Total OT Forecast vs OT Actual by Category



Total by Seat

8:03 am

Base
AllSeat
All

Legend

- RSV_CURRENT
- OT_ASSIGNED
- OT_CURRENT
- OT_FORECAST

FCST	12	13	23	16	24	22	18	19	18	17	27	17	13	8	21	21	18	11	22	17	196	160
OTA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OT	4	6	12	9	13	11	11	11	10	10	15	6	7	3	3	11	11	3	12	9	98	79

<---- Forecast
vs Actual

Open Time vs Available Reserves (AM/PM)

OT_AM	3	3	6	8	7	7	3	5	4	8	5	1	4	1	2	6	5	3	5	5	44	47
R_AM	3	3	5	10	5	7	5	5	7	6	4	6	2	4	8	9	2	4	3	5	44	59
OT_PM	1	3	6	1	6	4	8	6	6	2	10	5	3	2	1	5	6	0	7	4	54	32
R_PM	2	3	5	7	7	5	2	5	5	6	4	6	4	4	8	9	6	6	6	6	49	57

Total by Seat

Notes:

FCST = FORECAST OT
(updates daily)

OTA = OT Assign

OT = OT Current

R = Avail Rsv Blk
(updates hourly)

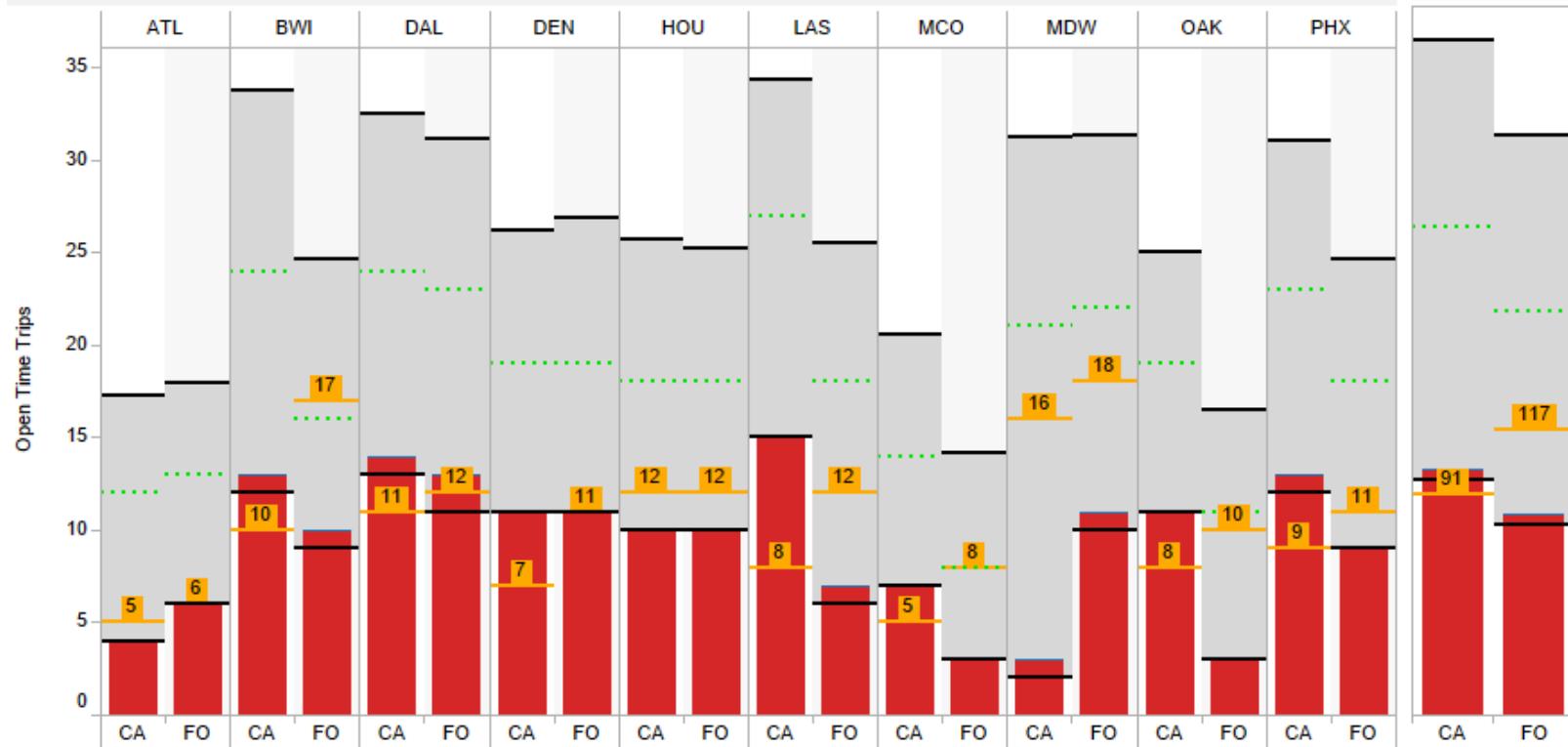
OT Assignments by Label

DOT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PREM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RSV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Total by Seat

DOT (D,E,F,H)
PREM (P,V,Q,J)
RSV (R,S)

Total OT Forecast vs OT Actual by Category



9:01 am

Total by Seat

Base
AllSeat
All

Legend

- RSV_CURRENT
- OT_ASSIGNED
- OT_CURRENT
- OT_FORECAST

	FCST	OTA	OT															
FCST	12	0	4	13	0	6	23	0	13	16	0	10	24	0	14	22	0	11
OTA	0	0	0	0	0	0	16	0	10	18	0	10	19	0	11	19	0	0
OT	4	0	13	10	0	14	22	0	11	11	0	10	15	0	7	7	0	3

<---- Forecast
vs Actual

	OT_AM	R_AM																
OT_AM	3	3	6	8	7	7	3	5	4	8	5	1	4	1	2	6	5	3
R_AM	3	3	5	10	4	7	5	6	7	6	4	6	2	4	8	9	2	4

Notes:
 FCST = FORECAST OT
 (updates daily)
 OTA = OT Assign
 OT = OT Current
 R = Avail Rsv Blk
 (updates hourly)

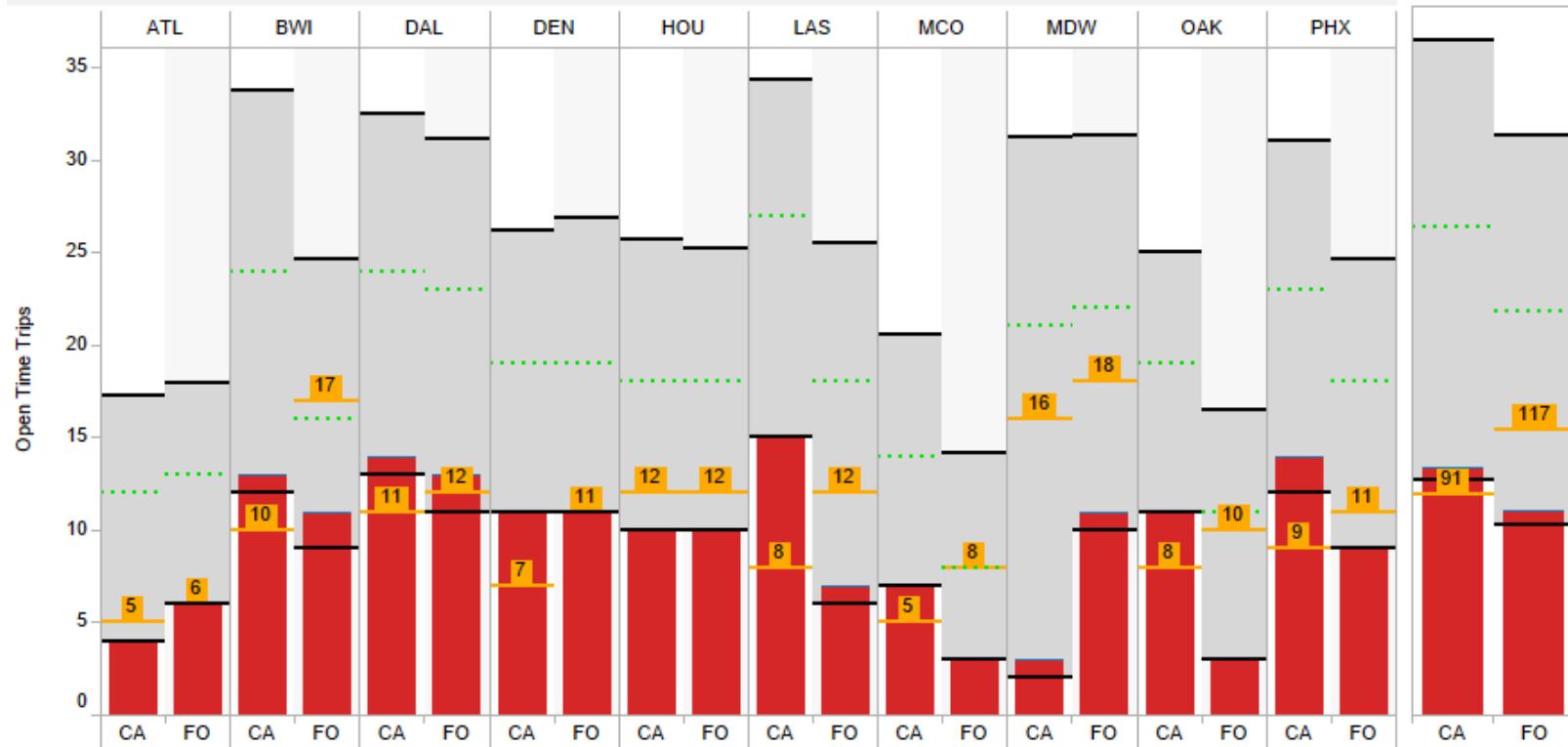
	OT_PM	R_PM																
OT_PM	1	3	7	2	7	6	8	6	6	2	10	6	3	2	1	5	6	0
R_PM	2	3	5	7	7	5	2	5	5	6	4	6	3	4	8	9	6	6

DOT (D,E,F,H)
 PREM (P,V,Q,J)
 RSV (R,S)

	OT_ASSIGNMENTS	OT_CURRENT	OT_RESERVED	OT_TOTAL	OT_ASSIGNMENTS	OT_CURRENT												
DOT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PREM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RSV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Total by Seat

Total OT Forecast vs OT Actual by Category



Total by Seat

10:02 am

Base
AllSeat
All

Legend

- RSV_CURRENT
- OT_ASSIGNED
- OT_CURRENT
- OT_FORECAST

FCST	12	13	23	16	24	22	18	19	18	17	27	17	13	8	21	21	18	11	22	17	196	160
OTA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
OT	4	6	13	11	14	13	11	11	10	10	15	7	7	3	3	11	11	3	14	9	102	84

<---- Forecast
vs Actual

Open Time vs Available Reserves (AM/PM)

OT_AM	3	3	6	9	7	7	3	5	4	8	5	1	4	1	2	6	5	3	6	5	45	48
R_AM	3	3	5	10	4	7	5	6	7	6	4	6	2	4	8	9	2	4	3	5	43	60
OT_PM	1	3	7	2	7	6	8	6	6	2	10	6	3	2	1	5	6	0	8	4	57	36
R_PM	2	3	5	7	7	5	2	5	5	6	4	6	3	4	8	9	6	6	6	6	48	57

Total by Seat

Notes:

FCST = FORECAST OT
(updates daily)

OTA = OT Assign

OT = OT Current

R = Avail Rsv Blk
(updates hourly)

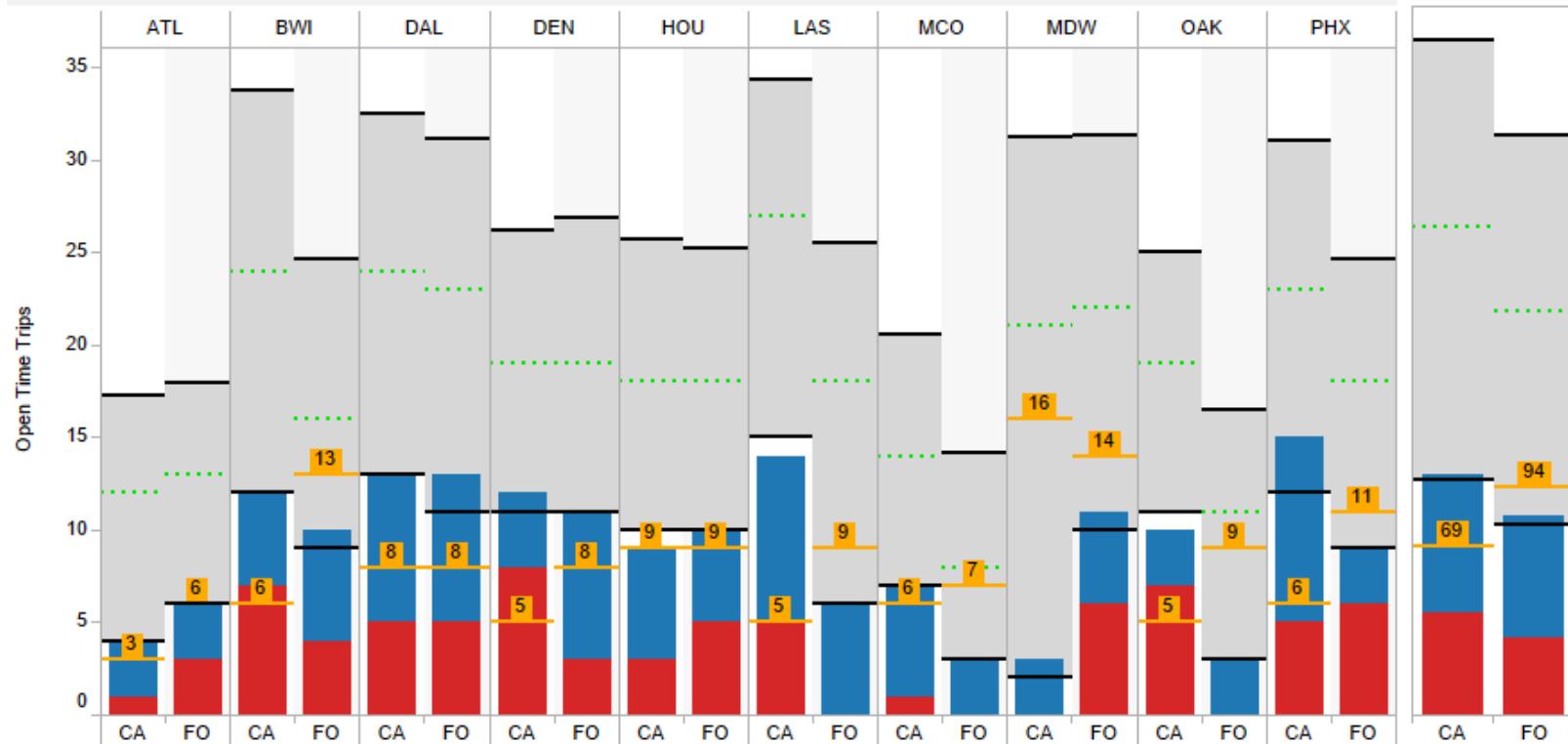
OT Assignments by Label

DOT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PREM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
RSV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Total by Seat

DOT (D,E,F,H)
PREM (P,V,Q,J)
RSV (R,S)

Total OT Forecast vs OT Actual by Category



11:05 am

Total by Seat

Base
AllSeat
All

Legend

- RSV_CURRENT
- OT_ASSIGNED
- OT_CURRENT
- OT_FORECAST

	<---- Forecast vs Actual														
FCST	12 13 23 16 24 22 18 19 18 17 27 17 13 8 21 21 18 11 22 17 196 160														
OTA	3 3 5 6 8 8 4 8 6 5 9 6 6 3 3 5 3 3 10 3 57 50														
OT	1 3 7 4 5 5 8 3 3 5 0 1 0 0 6 7 0 5 6 42 32														

Open Time vs Available Reserves (AM/PM)

	Total by Seat														
OT_AM	1 2 3 3 4 3 1 1 2 5 1 0 1 0 0 2 4 0 2 2 19 18														
R_AM	2 3 3 6 3 5 3 3 4 4 2 6 2 2 8 5 2 3 3 5 32 42														

	Total by Seat														
OT_PM	0 1 4 1 1 2 7 2 1 0 4 0 0 0 0 4 3 0 3 4 23 14														
R_PM	1 3 3 7 5 3 2 5 5 5 3 3 4 5 8 9 3 6 3 6 37 52														

OT Assignments by Label

	Total by Seat														
DOT	0 0 0 1 1 0 1 0 0 1 2 1 2 0 1 0 0 0 0 0 7 3														
PREM	0 0														
RSV	3 3 5 5 7 8 3 8 6 4 7 5 4 3 2 5 3 3 10 3 50 47														

Notes:

FCST = FORECAST OT (updates daily)

OTA = OT Assign

OT = OT Current

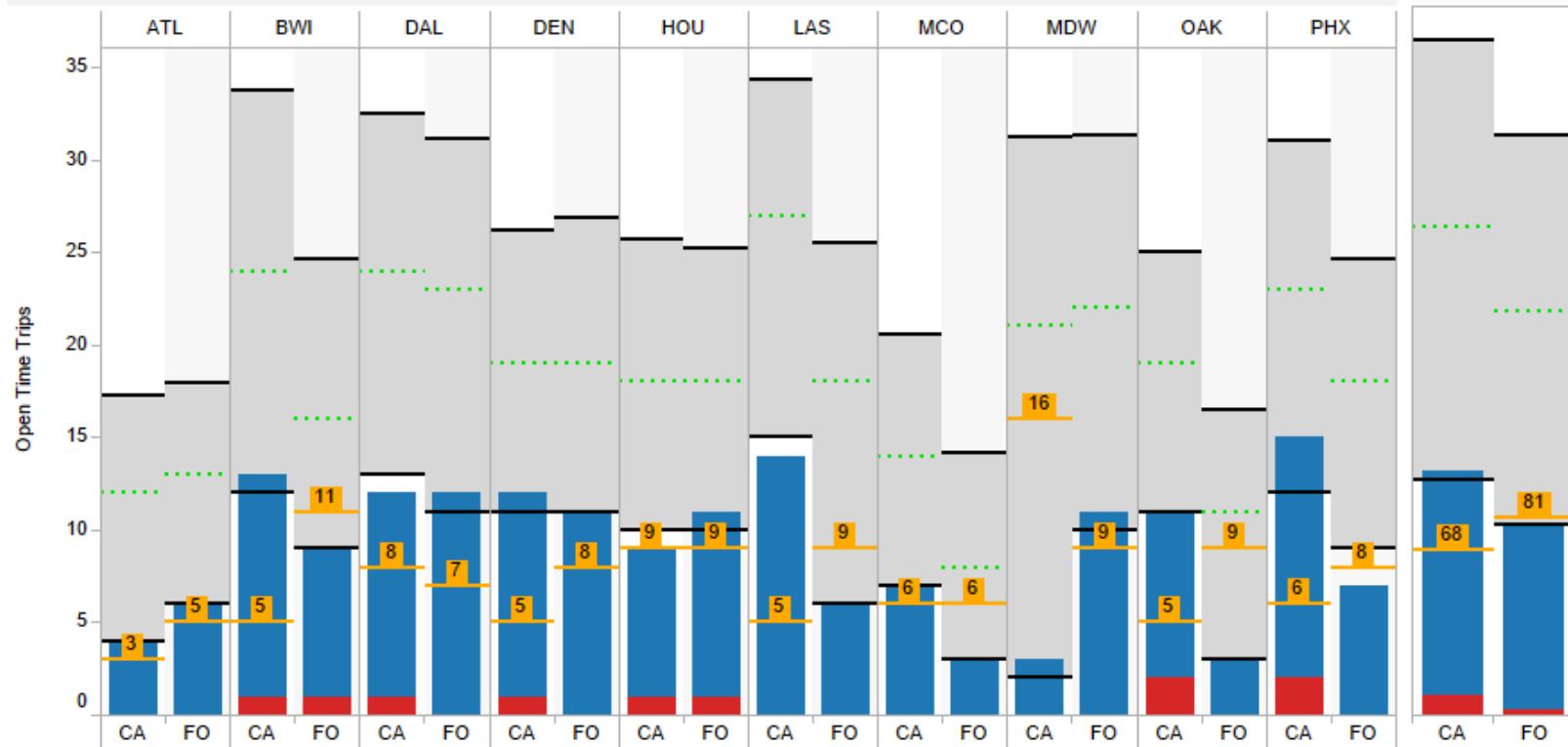
R = Avail Rsv Blk (updates hourly)

DOT (D,E,F,H)

PREM (P,V,Q,J)

RSV (S)

Total OT Forecast vs OT Actual by Category



Total by Seat

12:02 am

Base
AllSeat
All

Legend

- RSV_CURRENT
- OT_ASSIGNED
- OT_CURRENT
- OT_FORECAST

FCST	12	13	23	16	24	22	18	19	18	17	27	17	13	8	21	21	18	11	22	17	196	160
OTA	4	6	12	8	11	12	11	11	8	10	14	6	7	3	3	11	9	3	13	7	92	77
OT	0	0	1	1	1	0	1	0	1	1	0	0	0	0	0	0	2	0	2	0	8	2

<---- Forecast
vs Actual

OT_AM	0	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	2	0	1	0	4	2
R_AM	2	2	2	4	3	3	3	3	4	4	2	6	2	2	8	4	2	3	3	5	31	36

Notes:

FCST = FORECAST OT
(updates daily)

OT_PM	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	1	0	4	0
R_PM	1	3	3	7	5	4	2	5	5	5	3	3	4	4	8	5	3	6	3	3	37	45	

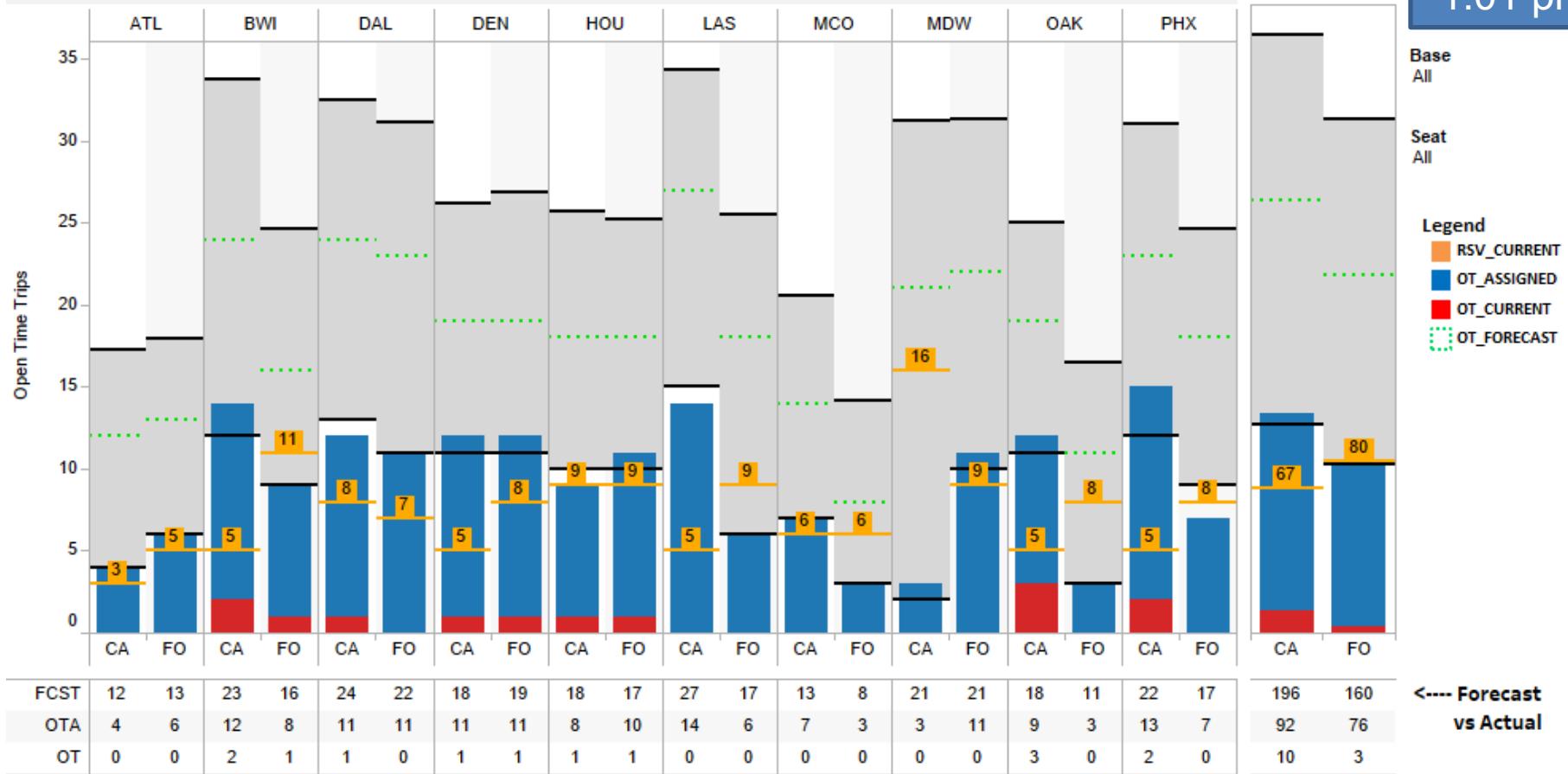
OTA = OT Assign
OT = OT Current
R = Avail Rsv Blk
(updates hourly)

DOT	0	0	0	1	1	0	1	0	0	1	2	1	2	0	1	0	0	0	0	0	7	3
PREM	1	2	7	1	4	3	7	3	3	5	5	0	1	0	0	2	6	0	3	1	37	17
RSV	3	4	5	6	6	9	3	8	5	4	7	5	4	3	2	9	3	3	10	6	48	57

Total by Seat

DOT (D,E,F,H)
PREM (P,V,Q,J)
RSV (R,S)

Total OT Forecast vs OT Actual by Category



Open Time vs Available Reserves (AM/PM)

	Total by Seat																													
OT_AM	0	0	1	1	1	0	0	1	0	1	0	0	0	0	0	3	0	1	0	6	3									
R_AM	2	2	2	4	3	3	3	3	4	4	2	6	2	2	8	4	2	2	3	5	31	35								
OT_PM	0	0	1	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	1	0	4	0								
R_PM	1	3	3	7	5	4	2	5	5	5	3	3	4	4	8	5	3	6	2	3	36	45								

OT Assignments by Label

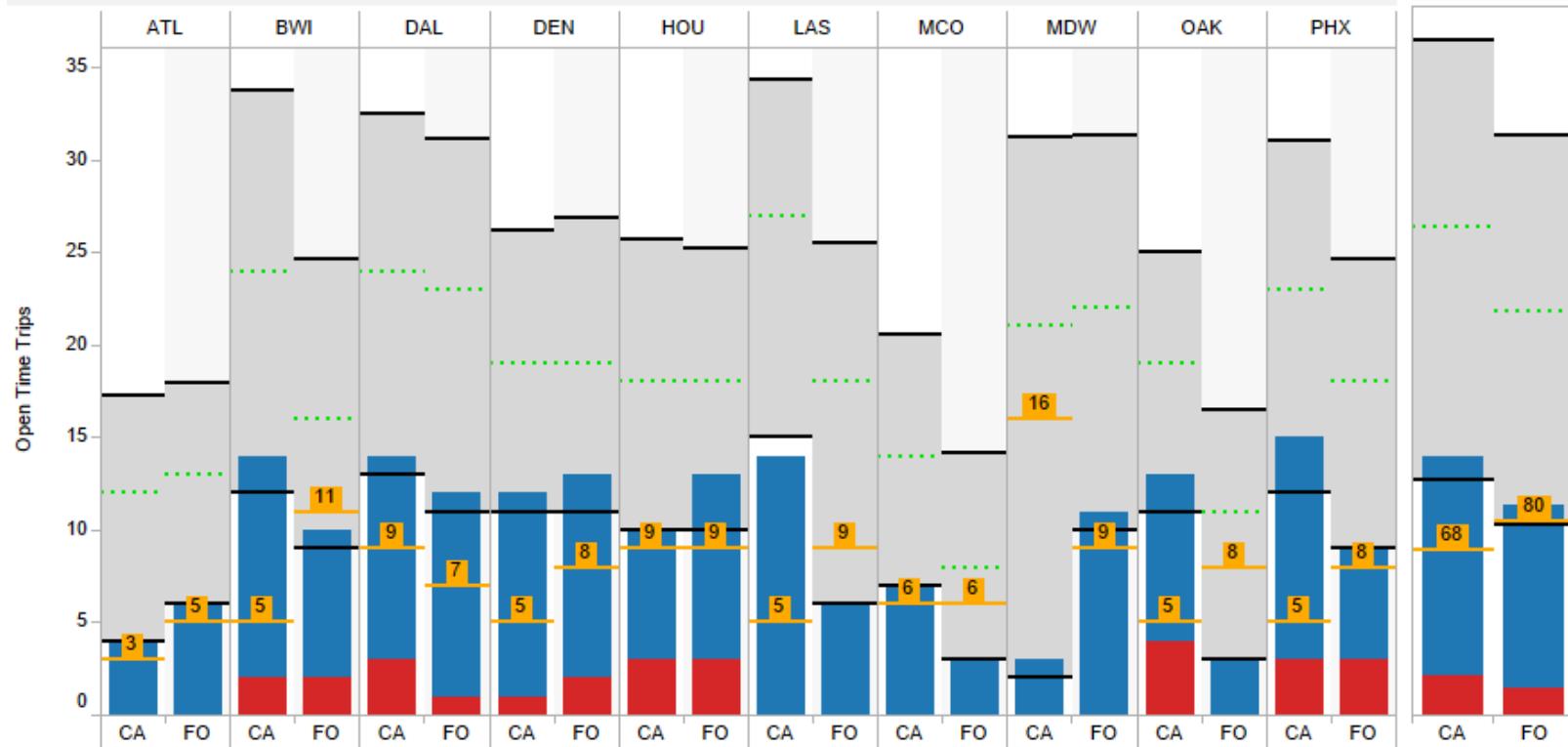
	Total by Seat																													
DOT	0	0	0	1	1	0	1	0	0	1	2	1	2	0	1	0	0	0	0	7	3									
PREM	1	2	7	1	4	3	7	3	3	5	5	0	1	0	0	2	6	0	3	1	37	17								
RSV	3	4	5	6	6	8	3	8	5	4	7	5	4	3	2	9	3	3	10	6	48	56								

Notes:
FCST = FORECAST OT
(updates daily)

OTA = OT Assign
OT = OT Current
R = Avail Rsv Blk
(updates hourly)

DOT (D,E,F,H)
PREM (P,V,Q,J)
RSV (R,S)

Total OT Forecast vs OT Actual by Category



	<---- Forecast vs Actual														
FCST	12 13 23 16 24 22 18 19 18 17 27 17 13 8 21 21 18 11 22 17														
OTA	4 6 12 8 11 11 11 11 7 10 14 6 7 3 3 11 9 3 12 6														
OT	0 0 2 2 3 1 1 2 3 3 0 0 0 0 0 4 0 3 3 16 11														

Open Time vs Available Reserves (AM/PM)

	Total by Seat														
OT_AM	0 0 1 2 3 1 0 2 1 2 0 0 0 0 0 4 0 1 2														
R_AM	2 2 2 4 3 3 3 3 4 4 2 6 2 2 8 4 2 2 3 5														
OT_PM	0 0 1 0 0 0 1 0 2 1 0 0 0 0 0 0 0 2 1														
R_PM	1 3 3 7 6 4 2 5 5 5 3 3 4 4 8 5 3 6 2 3														

OT Assignments by Label

	Total by Seat														
DOT	0 0 0 1 2 1 1 0 0 1 2 1 2 0 1 0 0 0 0														
PREM	1 2 7 1 4 3 7 3 3 5 5 0 1 0 0 2 6 0 3 1														
RSV	3 4 5 6 5 7 3 8 4 4 7 5 4 3 2 9 3 3 9 5														

Base
AllSeat
All

Legend

- RSV_CURRENT (Orange)
- OT_ASSIGNED (Blue)
- OT_CURRENT (Red)
- OT_FORECAST (Green)

<---- Forecast vs Actual

Notes:

FCST = FORECAST OT (updates daily)

OTA = OT Assign

OT = OT Current

R = Avail Rsv Blk (updates hourly)

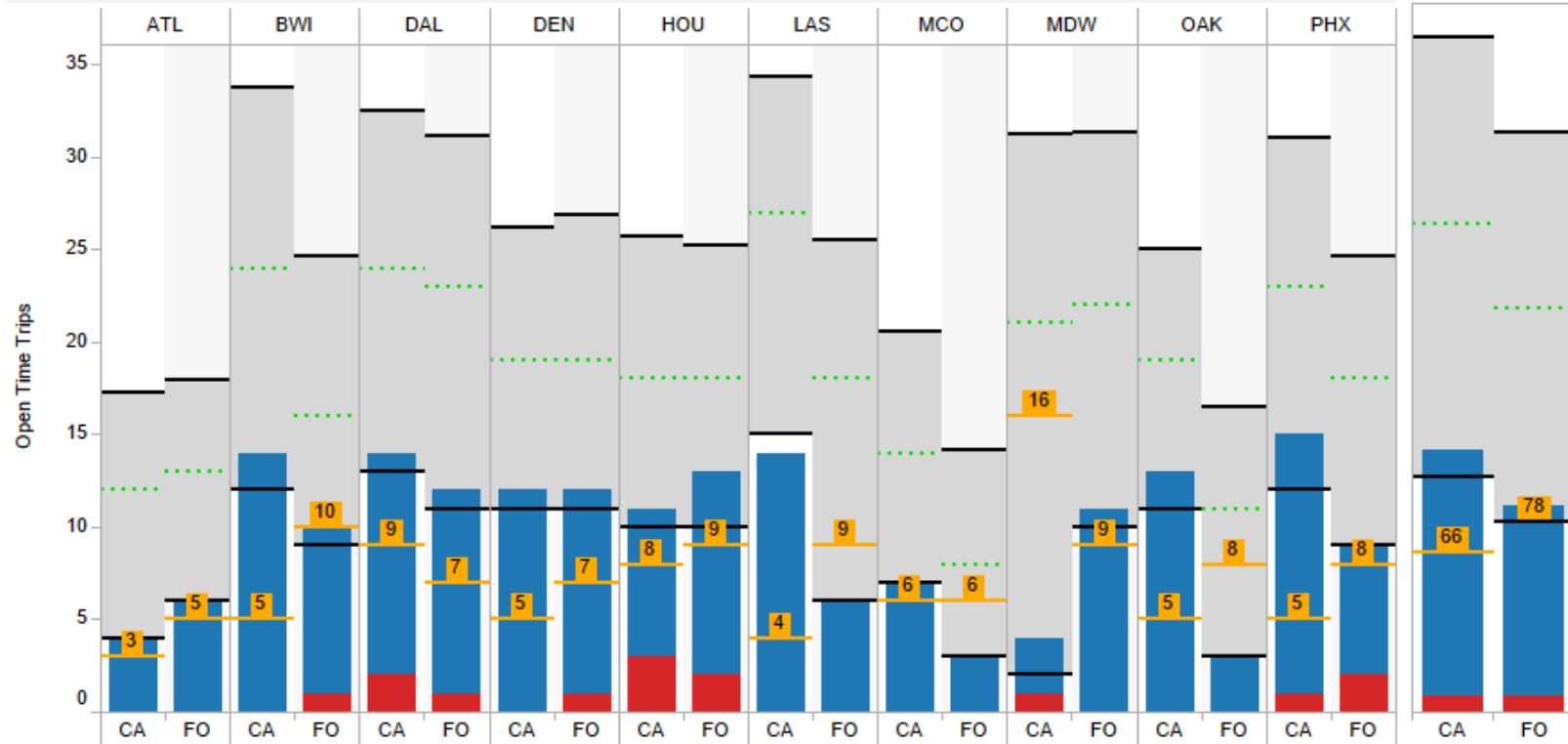
DOT (D,E,F,H)

PREM (P,V,Q,J)

RSV (S)

Total OT Forecast vs OT Actual by Category

3:01 pm

Base
AllSeat
All

Legend

- RSV_CURRENT
- OT_ASSIGNED
- OT_CURRENT
- OT_FORECAST

FCST	12	13	23	16	24	22	18	19	18	17	27	17	13	8	21	21	18	11	22	17	196	160
OTA	4	6	14	9	12	11	12	11	8	11	14	6	7	3	3	11	13	3	14	7	101	78
OT	0	0	0	1	2	1	0	1	3	2	0	0	0	0	1	0	0	0	1	2	7	7

<---- Forecast
vs Actual

Open Time vs Available Reserves (AM/PM)																	Total by Seat					
OT_AM	0	0	0	1	2	1	0	1	2	1	0	0	0	0	1	0	0	0	1			
R_AM	2	2	2	3	3	3	3	3	4	4	2	6	2	2	8	4	2	2	3	31	34	
OT_PM	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	2	2	
R_PM	1	3	3	7	6	4	2	4	4	5	2	3	4	4	8	5	3	6	2	3	35	44

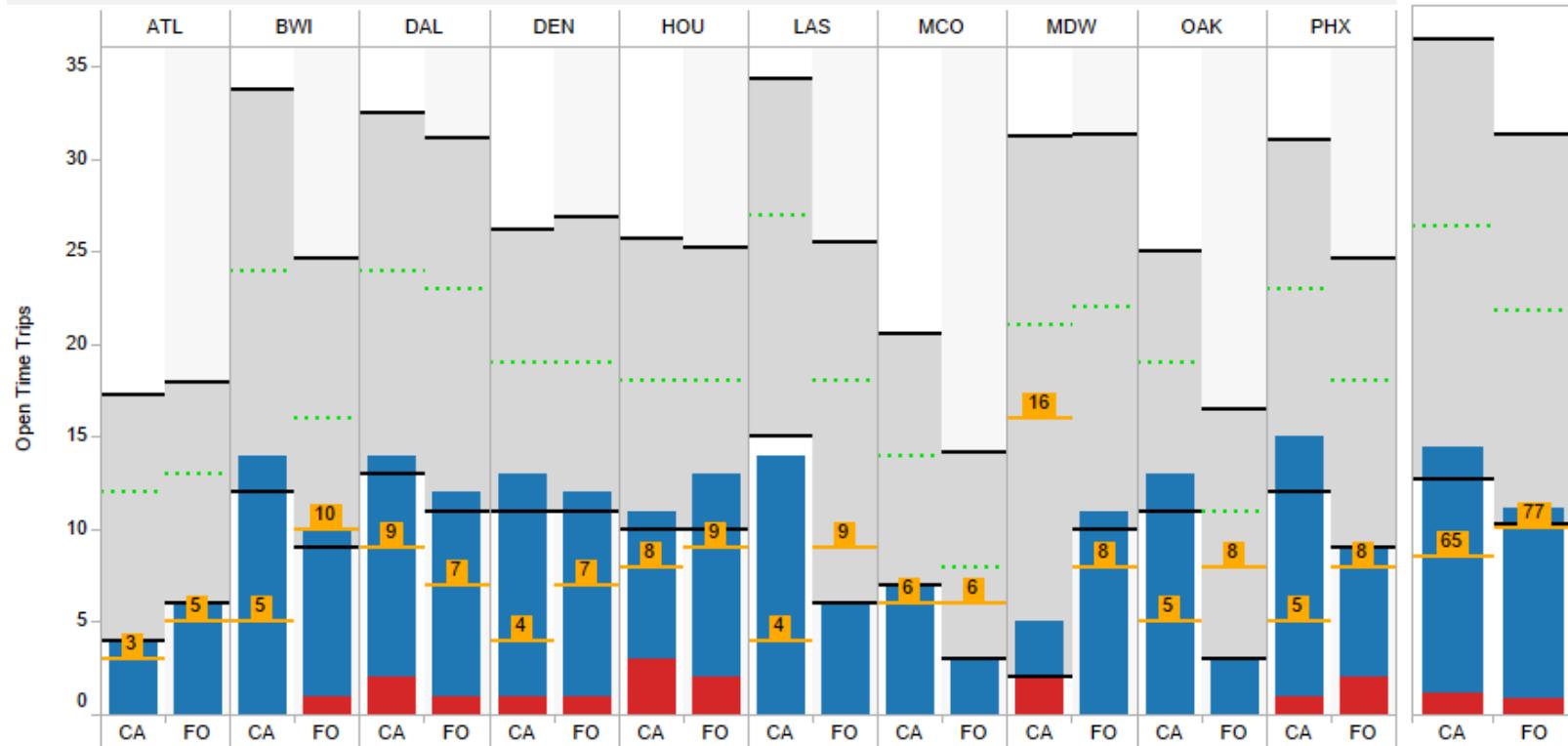
Notes:
 FCST = FORECAST OT
 (updates daily)

OTA = OT Assign
 OT = OT Current
 R = Avail Rsv Blk
 (updates hourly)

OT Assignments by Label																	Total by Seat			
DOT	0	0	1	1	3	1	1	0	0	1	2	1	2	0	1	0	1	1		
PREM	1	2	8	1	4	3	8	3	3	6	5	0	1	0	0	2	8	0	42	18
RSV	3	4	5	7	5	7	3	8	5	4	7	5	4	3	2	9	4	3	9	55

DOT (D,E,F,H)
 PREM (P,V,Q,J)
 RSV (R,S)

Total OT Forecast vs OT Actual by Category



Total by Seat

4:02 pm

Base
AllSeat
All

Legend

- RSV_CURRENT
- OT_ASSIGNED
- OT_CURRENT
- OT_FORECAST

FCST	12	13	23	16	24	22	18	19	18	17	27	17	13	8	21	21	18	11	22	17	196	160
OTA	4	6	14	9	12	11	12	11	8	11	14	6	7	3	3	11	13	3	14	7	101	78
OT	0	0	0	1	2	1	1	1	3	2	0	0	0	0	2	0	0	0	1	2	9	7

<---- Forecast
vs Actual

Open Time vs Available Reserves (AM/PM)

OT_AM	0	0	0	1	2	1	0	1	2	1	0	0	0	0	1	0	0	0	0	1	5	5
R_AM	2	2	2	3	3	3	3	3	4	4	2	6	2	2	8	3	2	2	3	5	31	33
OT_PM	0	0	0	0	0	0	1	0	1	1	0	0	0	0	1	0	0	0	0	1	1	4
R_PM	1	3	3	7	6	4	1	4	4	5	2	3	4	4	8	5	3	6	2	3	34	44

Total by Seat

Notes:

FCST = FORECAST OT
(updates daily)

OTA = OT Assign

OT = OT Current

R = Avail Rsv Blk
(updates hourly)

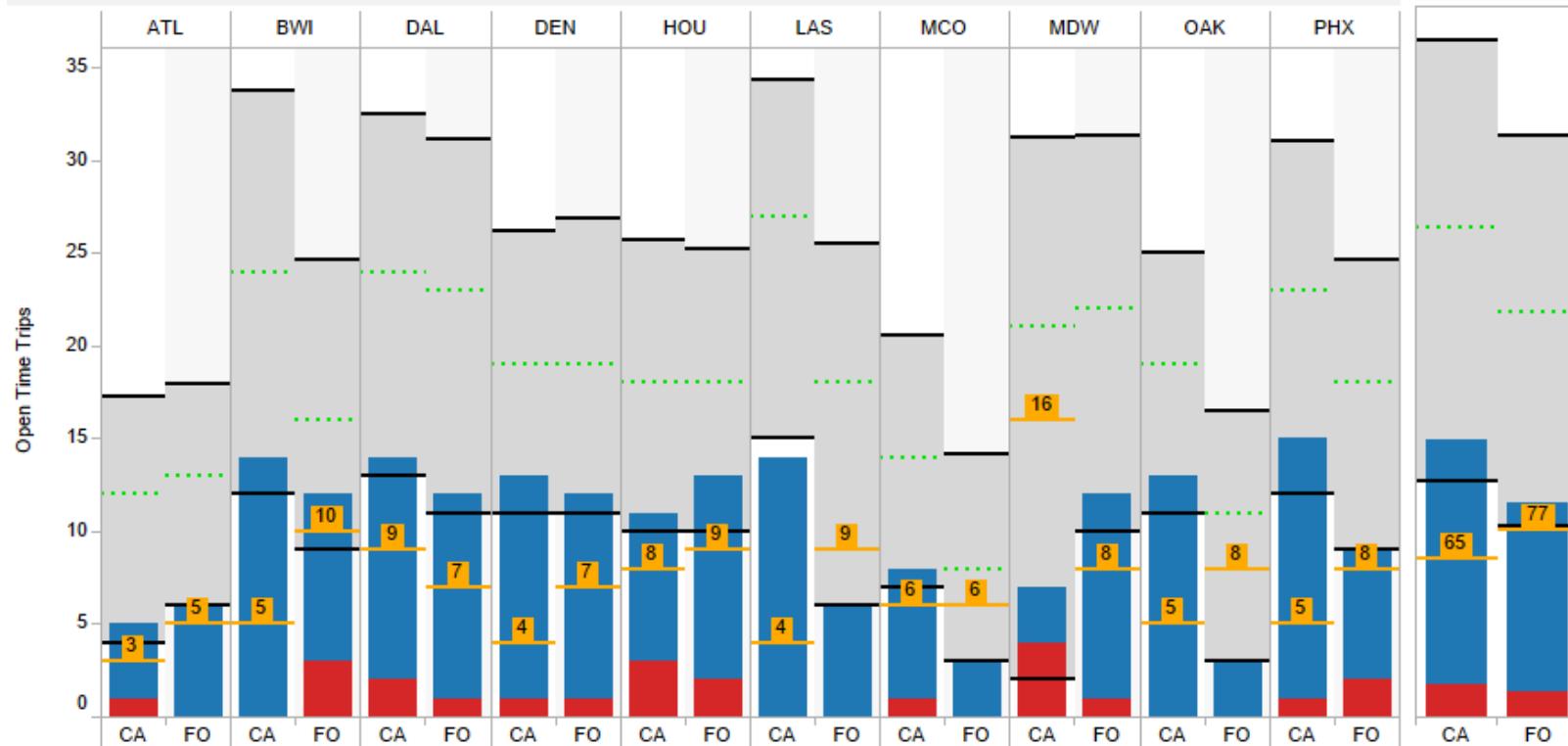
OT Assignments by Label

DOT	0	0	1	1	3	1	1	0	0	1	2	1	2	0	1	0	1	0	1	1	12	5
PREM	1	2	8	1	4	3	8	3	3	6	5	0	1	0	0	2	8	0	4	1	42	18
RSV	3	4	5	7	5	7	3	8	5	4	7	5	4	3	2	9	4	3	9	5	47	55

Total by Seat

DOT (D,E,F,H)
PREM (P,V,Q,J)
RSV (R,S)

Total OT Forecast vs OT Actual by Category



Total by Seat

5:01 pm

Base
AllSeat
All

Legend

- RSV_CURRENT
- OT_ASSIGNED
- OT_CURRENT
- OT_FORECAST

FCST	12	13	23	16	24	22	18	19	18	17	27	17	13	8	21	21	18	11	22	17	196	160
OTA	4	6	14	9	12	11	12	11	8	11	14	6	7	3	3	11	13	3	14	7	101	78
OT	1	0	0	3	2	1	1	1	3	2	0	0	1	0	4	1	0	0	1	2	13	10

<---- Forecast
vs Actual

Open Time vs Available Reserves (AM/PM)

OT_AM	1	0	0	2	2	1	0	1	2	1	0	0	1	0	2	1	0	0	0	1	8	7
R_AM	2	2	2	3	3	3	3	3	4	4	2	6	2	2	8	3	2	2	3	5	31	33

OT_PM	0	0	0	1	0	0	1	0	1	1	0	0	0	0	2	0	0	0	0	1	1	5	3
R_PM	1	3	3	7	6	4	1	4	4	5	2	3	4	4	8	5	3	6	2	3	34	44	

Total by Seat

Notes:

FCST = FORECAST OT
(updates daily)

OTA = OT Assign

OT = OT Current

R = Avail Rsv Blk
(updates hourly)

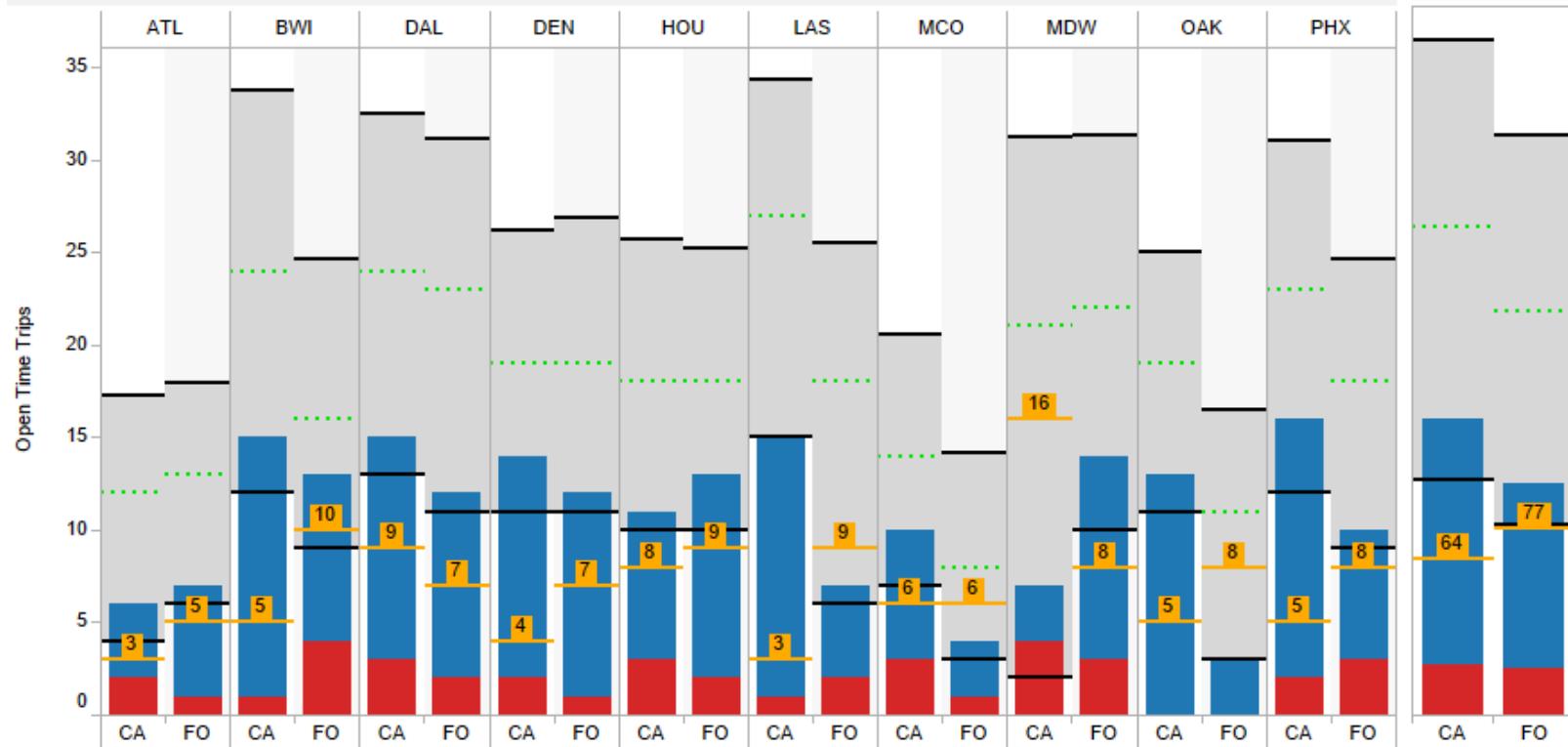
OT Assignments by Label

DOT	0	0	1	1	3	1	1	0	0	1	2	1	2	0	1	0	1	0	1	1	12	5
PREM	1	2	8	1	4	3	8	3	3	6	5	0	1	0	0	2	8	0	4	1	42	18
RSV	3	4	5	7	5	7	3	8	5	4	7	5	4	3	2	9	4	3	9	5	47	55

Total by Seat

DOT (D,E,F,H)
PREM (P,V,Q,J)
RSV (R,S)

Total OT Forecast vs OT Actual by Category



Total by Seat

6:01 pm

Base
All
Seat
All

Legend
█ RSV_CURRENT
█ OT_ASSIGNED
█ OT_CURRENT
█ OT_FORECAST

FCST	12	13	23	16	24	22	18	19	18	17	27	17	13	8	21	21	18	11	22	17	196	160
OTA	4	6	14	9	12	10	12	11	8	11	14	5	7	3	3	11	13	3	14	7	101	76
OT	2	1	1	4	3	2	2	1	3	2	1	2	3	1	4	3	0	0	2	3	21	19

<---- Forecast
vs Actual

OT_AM	1	0	1	2	3	2	0	1	2	1	1	1	2	0	2	2	0	0	0	1	12	10
R_AM	2	2	2	3	3	3	3	3	4	4	2	6	2	2	8	3	2	2	3	5	31	33

OT_PM	1	1	0	2	0	0	2	0	1	1	0	1	1	1	2	1	0	0	2	2	9	9
R_PM	1	3	3	7	6	4	1	4	4	5	1	3	4	4	8	5	3	6	2	3	33	44

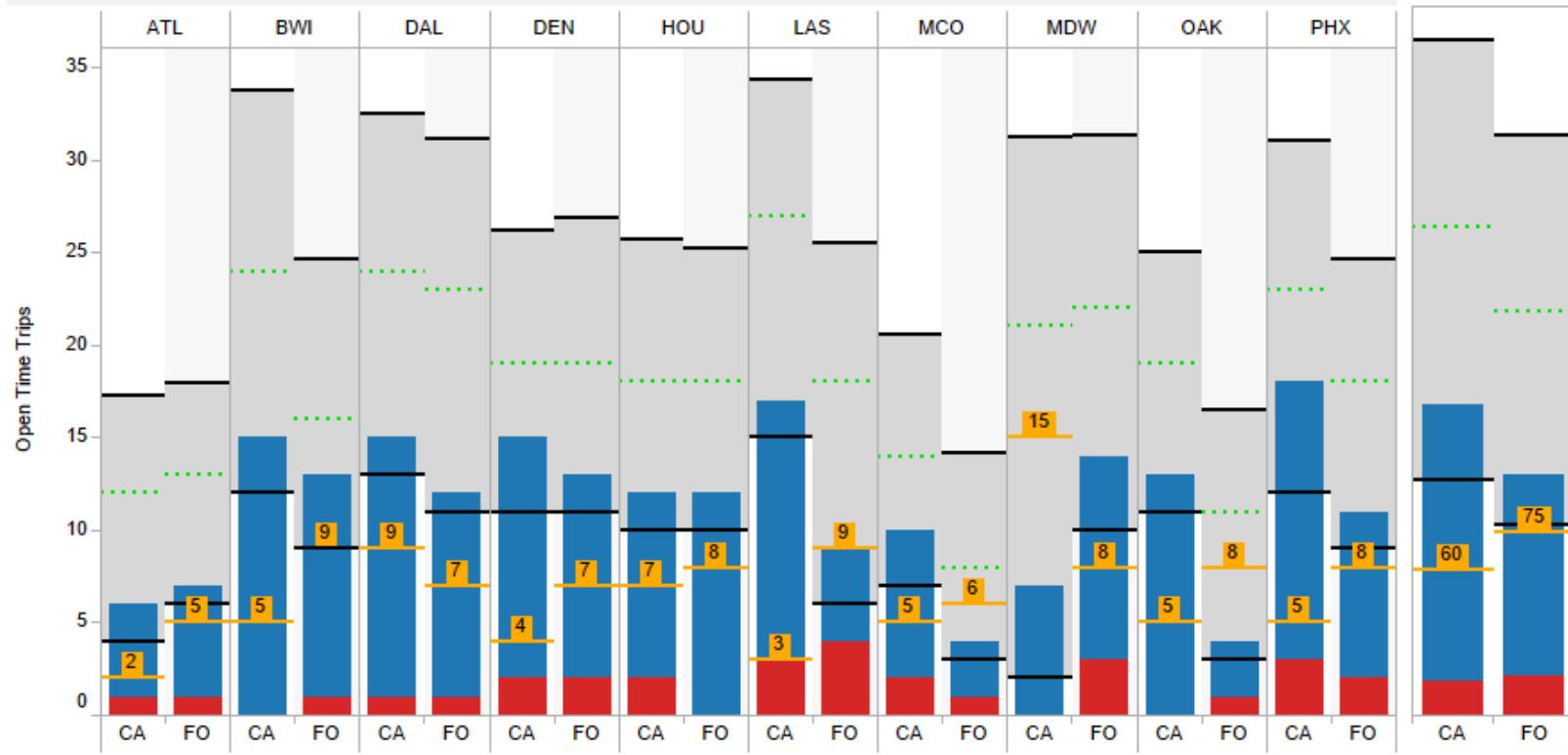
OT Assignments by Label	0	0	1	1	3	1	1	0	0	1	2	1	2	0	1	0	1	0	1	1	12	5
PREM	1	2	8	1	4	3	8	3	3	6	5	0	1	0	0	2	8	0	4	1	42	18
RSV	3	4	5	7	5	6	3	8	5	4	7	4	4	3	2	9	4	3	9	5	47	53

Notes:
 FCST = FORECAST OT
 (updates daily)

OTA = OT Assign
 OT = OT Current
 R = Avail Rsv Blk
 (updates hourly)

DOT (D,E,F,H)
 PREM (P,V,Q,J)
 RSV (R,S)

Total OT Forecast vs OT Actual by Category



7:01 pm

Total by Seat

Base
AllSeat
All

Legend

- RSV_CURRENT
- OT_ASSIGNED
- OT_CURRENT
- OT_FORECAST

	<---- Forecast vs Actual														
FCST	12 13 23 16 24 22 18 19 18 17 27 17 13 8 21 21 18 11 22 17														
OTA	5 6 15 12 14 11 13 11 10 12 14 5 8 3 7 11 13 3 15 9														
OT	1 1 0 1 1 1 2 2 2 0 3 4 2 1 0 3 0 1 3 2														

Open Time vs Available Reserves (AM/PM)

	Total by Seat														
OT_AM	0 0 0 0 1 1 1 1 2 0 2 1 1 0 0 2 0 0 1 0														
R_AM	1 2 2 2 3 3 3 3 2 6 2 2 8 3 2 2 3 5														
OT_PM	1 1 0 1 0 0 1 1 0 0 1 3 1 1 0 1 0 1 2 2														
R_PM	1 3 3 7 6 4 1 4 4 5 1 3 3 4 7 5 3 6 2 3														

OT Assignments by Label

	Total by Seat														
DOT	0 0 1 3 4 2 1 0 1 1 2 1 3 0 4 0 1 0 2 3														
PREM	1 2 9 1 5 3 8 3 4 6 5 0 1 0 0 2 8 0 4 1														
RSV	4 4 5 8 5 6 4 8 5 5 7 4 4 3 3 9 4 3 9 5														

Notes:

FCST = FORECAST OT (updates daily)

OTA = OT Assign

OT = OT Current

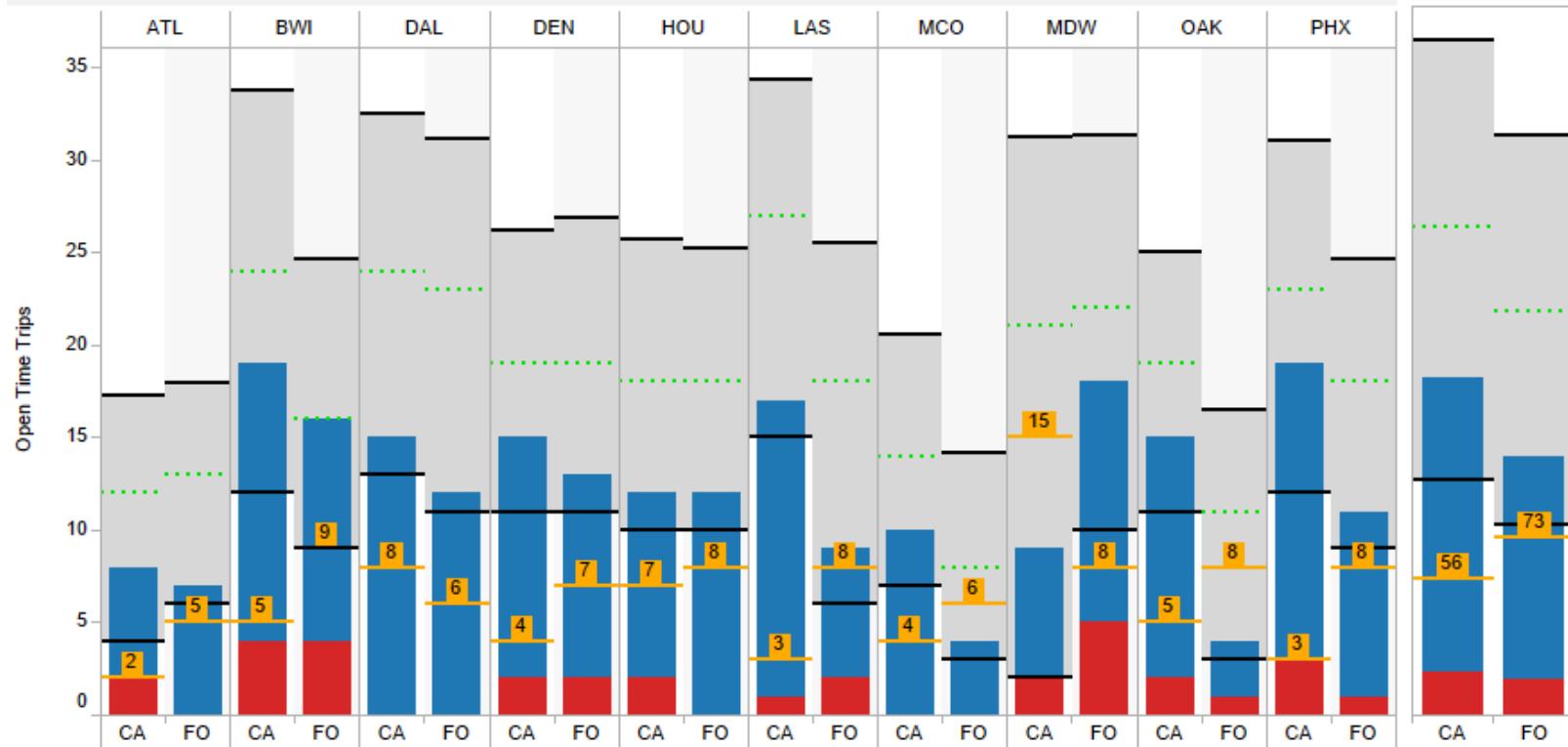
R = Avail Rsv Blk (updates hourly)

DOT (D,E,F,H)

PREM (P,V,Q,J)

RSV (S)

Total OT Forecast vs OT Actual by Category



	FCST	12	13	23	16	24	22	18	19	18	17	27	17	13	8	21	21	18	11	22	17	196	160
	OTA	6	7	15	12	15	12	13	11	10	12	16	7	10	4	7	13	13	3	16	10	121	91
	OT	2	0	4	4	0	0	2	2	2	0	1	2	0	0	2	5	2	1	3	1	18	15

<---- Forecast vs Actual

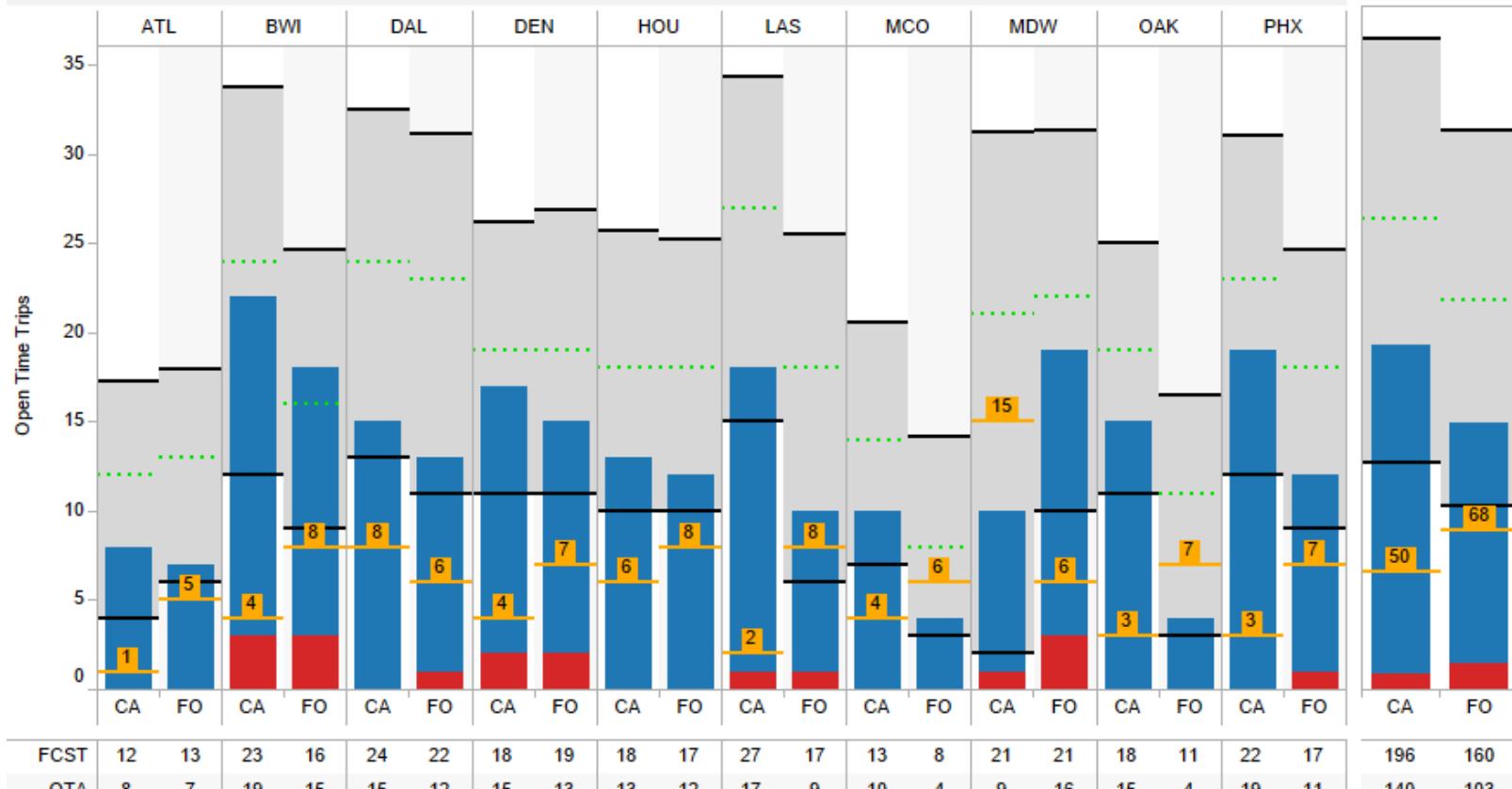
	Open Time vs Available Reserves (AM/PM)												Total by Seat								
OT_AM	1	0	2	1	0	0	1	1	2	0	0	0	0	1	2	1	0	1	0	9	4
R_AM	1	2	2	2	2	2	3	3	3	3	2	6	1	2	8	3	2	2	2	26	30

	OT_ASSIGNMENTS by Label												Total by Seat									
DOT	1	1	1	3	4	2	1	0	1	1	3	2	4	1	4	1	1	0	2	3	22	14
PREM	1	2	9	1	5	3	8	3	4	6	5	0	1	0	0	3	8	0	4	2	45	20
RSV	4	4	5	8	6	7	4	8	5	5	8	5	5	3	3	9	4	3	10	5	54	57

Notes:
 FCST = FORECAST OT (updates daily)
 OTA = OT Assign
 OT = OT Current
 R = Avail Rsv Blk (updates hourly)

DOT (D,E,F,H)
 PREM (P,V,Q,J)
 RSV (R,S)

Total OT Forecast vs OT Actual by Category



Total by Seat

9:01 pm

Base
AllSeat
All

Legend

- RSV_CURRENT
- OT_ASSIGNED
- OT_CURRENT
- OT_FORECAST

Open Time vs Available Reserves (AM/PM)

OT_AM	0	0	2	3	0	1	1	1	0	0	1	1	0	0	1	1	0	0	0	1	5	8
-------	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

R_AM	0	2	1	2	2	2	3	3	2	3	1	6	1	2	8	2	1	2	2	5	21	29
------	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	----	----

OT_PM	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	2	0	0	0	0	2	3
-------	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

R_PM	1	3	3	6	6	4	1	4	4	5	1	2	3	4	7	4	2	5	1	2	29	39
------	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	----	----

OT Assignments by Label

DOT	1	1	1	3	4	2	2	2	1	4	3	5	1	6	2	1	0	3	3	29	18	
PREM	1	2	12	3	5	3	9	3	5	6	5	1	1	0	0	4	8	0	6	2	52	24
RSV	6	4	6	9	6	7	4	8	6	5	8	5	4	3	3	10	6	4	10	6	59	61

Notes:

FCST = FORECAST OT
(updates daily)

OTA = OT Assign

OT = OT Current

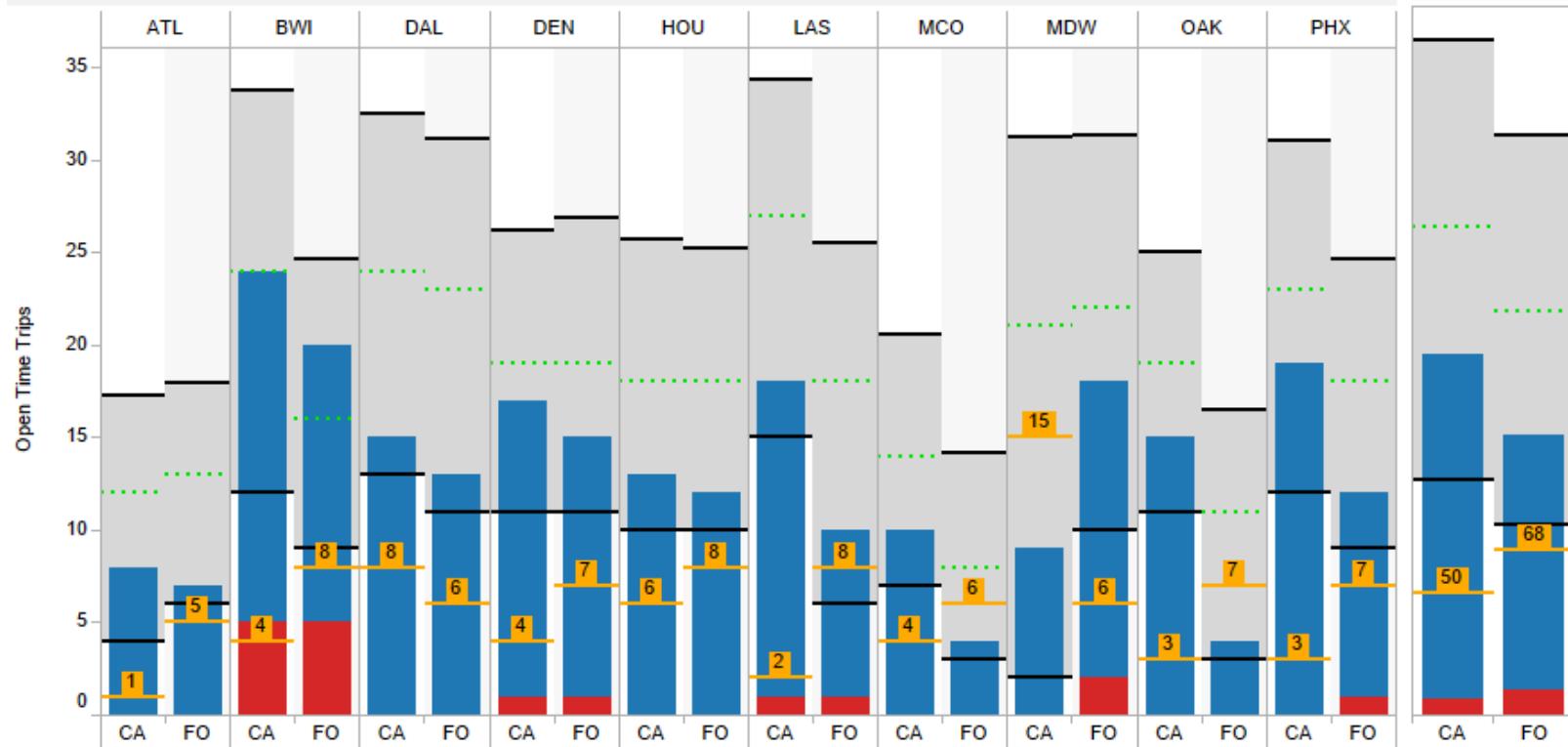
R = Avail Rsv Blk
(updates hourly)

DOT (D,E,F,H)

PREM (P,V,Q,J)

RSV (S)

Total OT Forecast vs OT Actual by Category



	<---- Forecast vs Actual														
FCST	12 13 23 16 24 22 18 19 18 17 27 17 13 8 21 21 18 11 22 17														
OTA	8 7 19 15 15 13 16 14 13 12 17 9 10 4 9 16 15 4 19 11														
OT	0 0 5 5 0 0 1 1 0 0 1 1 0 0 0 2 0 0 0 1														

Open Time vs Available Reserves (AM/PM)

	Total by Seat														
OT_AM	0 0 4 4 0 0 0 0 0 1 1 0 0 0 0 0 1														
R_AM	0 2 1 2 2 2 3 3 2 3 1 6 1 2 8 2 1 2 2 5														
OT_PM	0 0 1 1 0 0 1 1 0 0 0 0 0 0 0 2 0 0 0 0														
R_PM	1 3 3 6 6 4 1 4 4 5 1 2 3 4 7 4 2 5 1 2														

OT Assignments by Label

	Total by Seat														
DOT	1 1 1 3 4 3 3 3 2 1 4 3 5 1 6 2 1 0 3 3														
PREM	1 2 12 3 5 3 9 3 5 6 5 1 1 0 0 4 8 0 6 2														
RSV	6 4 6 9 6 7 4 8 6 5 8 5 4 3 3 10 6 4 10 6														

Base All
Seat All

Legend
█ RSV_CURRENT
█ OT_ASSIGNED
█ OT_CURRENT
█ OT_FORECAST

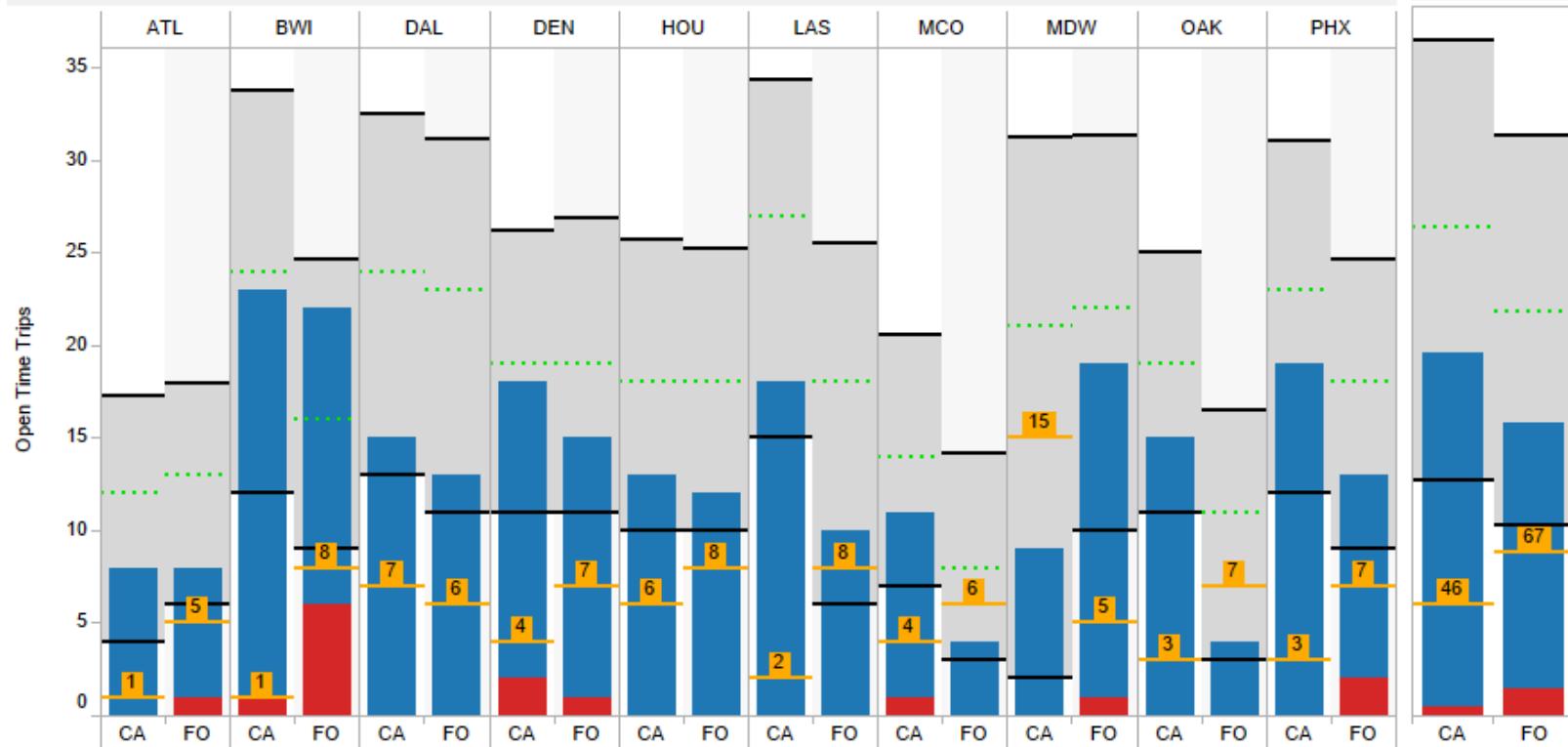
<---- Forecast vs Actual

Notes:
 FCST = FORECAST OT (updates daily)

OTA = OT Assign
 OT = OT Current
 R = Avail Rsv Blk (updates hourly)

DOT (D,E,F,H)
 PREM (P,V,Q,J)
 RSV (R,S)

Total OT Forecast vs OT Actual by Category



Total by Seat

11:02 pm

Base
AllSeat
All

Legend

- RSV_CURRENT
- OT_ASSIGNED
- OT_CURRENT
- OT_FORECAST

FCST	12	13	23	16	24	22	18	19	18	17	27	17	13	8	21	21	18	11	22	17	196	160
OTA	8	7	22	16	15	13	16	14	13	12	18	10	10	4	9	18	15	4	19	11	145	109
OT	0	1	1	6	0	0	2	1	0	0	0	0	1	0	0	1	0	0	0	2	4	11

<---- Forecast
vs Actual

Open Time vs Available Reserves (AM/PM)

OT_AM	0	0	1	4	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	2	5	
R_AM	0	2	0	2	2	2	3	3	2	3	1	6	1	2	8	2	1	2	2	5	20	29
OT_PM	0	1	0	2	0	0	2	1	0	0	0	0	0	0	0	1	0	0	0	1	2	6
R_PM	1	3	1	6	5	4	1	4	4	5	1	2	3	4	7	3	2	5	1	2	26	38

Total by Seat

Notes:
 FCST = FORECAST OT
 (updates daily)

OTA = OT Assign

OT = OT Current

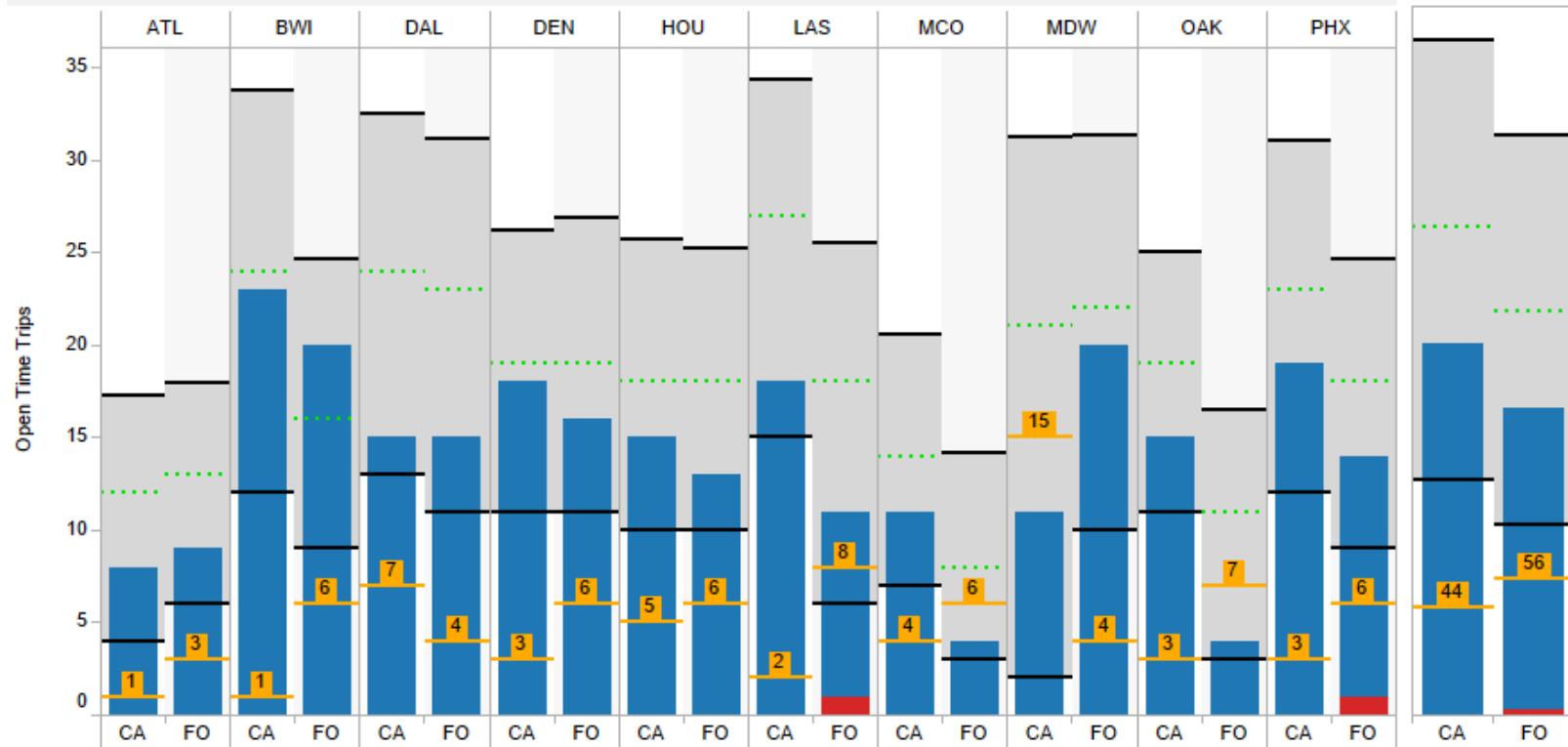
R = Avail Rsv Blk
 (updates hourly)

DOT	1	1	2	3	4	3	3	3	2	1	4	3	5	1	6	2	1	0	3	3	31	20
PREM	1	2	12	4	5	3	9	3	5	6	6	2	1	0	0	5	8	0	6	2	53	27
RSV	6	4	8	9	6	7	4	8	6	5	8	5	4	3	3	11	6	4	10	6	61	62

Total by Seat

DOT (D,E,F,H)
 PREM (P,V,Q,J)
 RSV (R,S)

Total OT Forecast vs OT Actual by Category



Total by Seat

3:01 am

Base
AllSeat
All

Legend

- RSV_CURRENT
- OT_ASSIGNED
- OT_CURRENT
- OT_FORECAST

	12	13	23	16	24	22	18	19	18	17	27	17	13	8	21	21	18	11	22	17	196	160
FCST	8	9	23	20	15	15	18	16	15	13	18	10	11	4	11	20	15	4	19	13	153	124
OTA	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	2	

<---- Forecast
vs Actual

	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1
OT_AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
R_AM	0	1	0	0	2	0	3	3	2	1	1	6	1	2	8	2	1	2	2	5	20	22

	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
OT_PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
R_PM	1	2	1	6	5	4	0	3	3	5	1	2	3	4	7	2	2	5	1	1	24	34

	1	1	2	3	4	3	3	4	3	1	3	3	6	1	7	2	1	0	3	3	33	21
DOT	1	1	2	3	4	3	3	4	3	1	3	3	6	1	7	2	1	0	3	3	33	21
PREM	1	2	13	5	5	3	10	3	5	5	7	2	1	0	1	6	8	0	6	2	57	28
RSV	6	6	8	12	6	9	5	9	7	7	8	5	4	3	3	12	6	4	10	8	63	75

Notes:

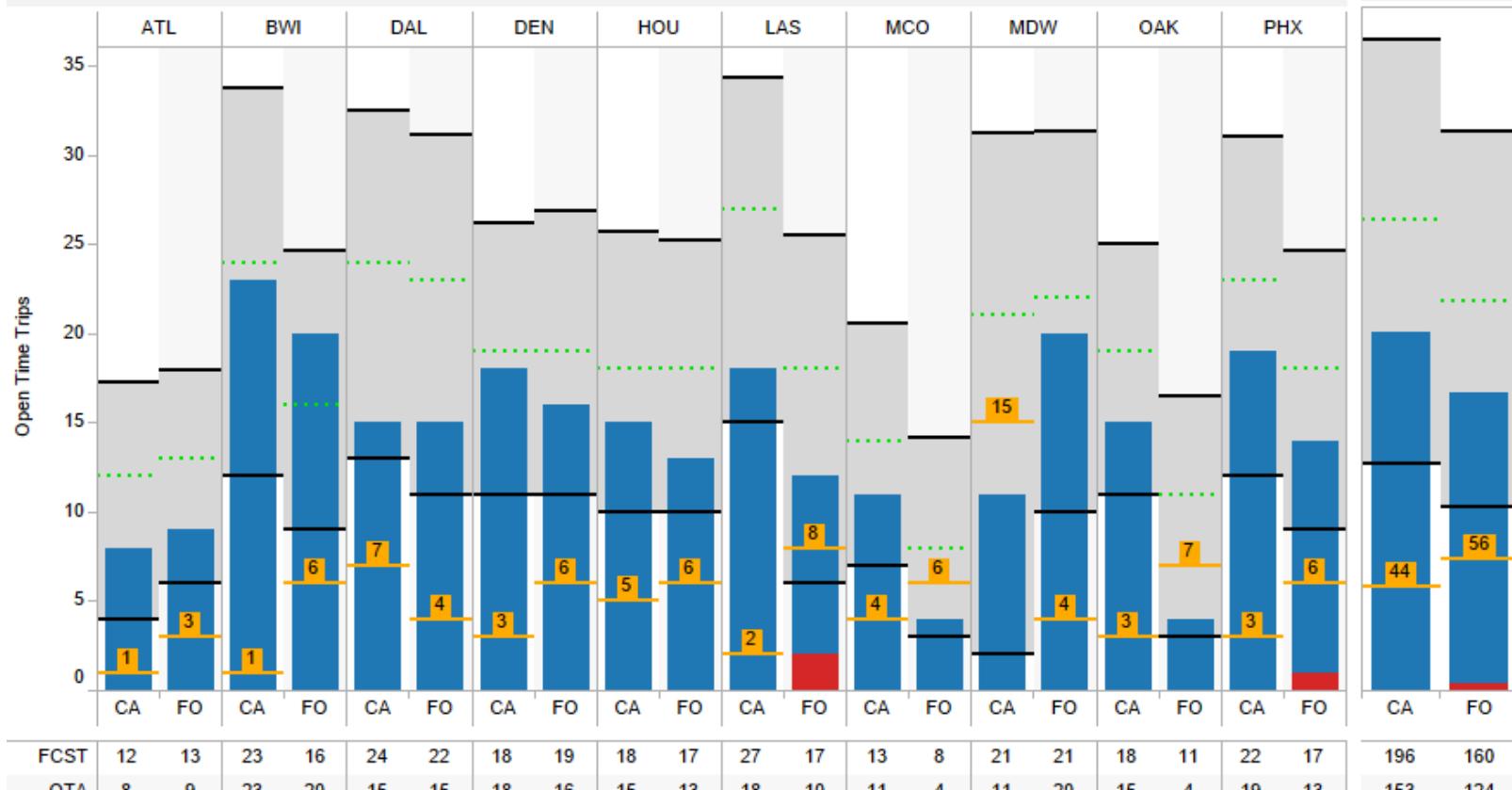
FCST = FORECAST OT
(updates daily)

OTA = OT Assign

OT = OT Current

R = Avail Rsv Blk
(updates hourly)DOT (D,E,F,H)
PREM (P,V,Q,J)
RSV (R,S)

Total OT Forecast vs OT Actual by Category



Total by Seat

4:01 am

Base
AllSeat
All

Legend

- RSV_CURRENT
- OT_ASSIGNED
- OT_CURRENT
- OT_FORECAST

Open Time vs Available Reserves (AM/PM)

	Total by Seat														
OT_AM	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1														
R_AM	0 1 0 0 2 0 3 3 2 1 1 6 1 2 8 2														
OT_PM	0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0														
R_PM	1 2 1 6 5 4 0 3 3 5 1 2 3 4 7 2														

Total by Seat

Notes:

FCST = FORECAST OT
(updates daily)

OTA = OT Assign

OT = OT Current

R = Avail Rsv Blk
(updates hourly)

OT Assignments by Label

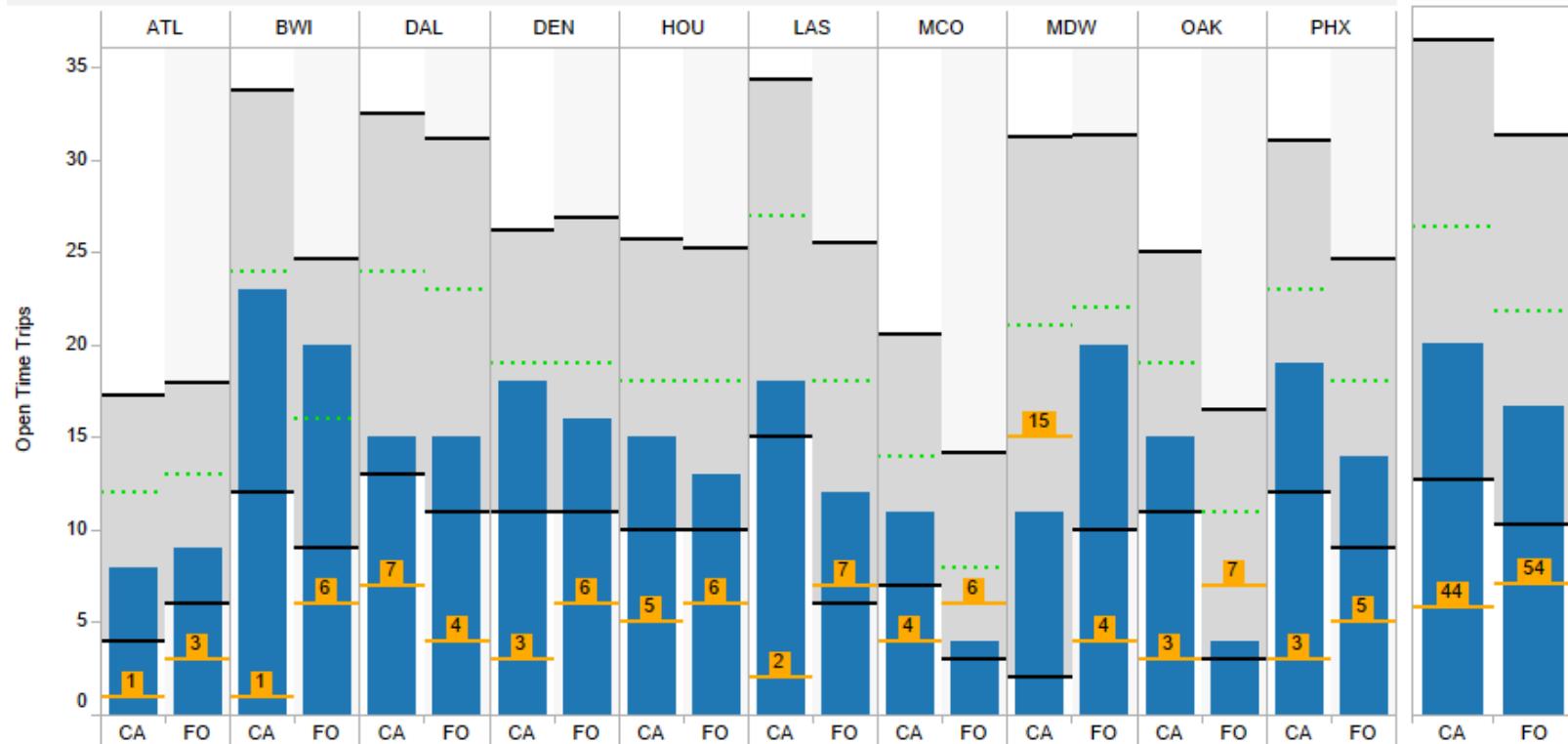
	Total by Seat														
DOT	1 1 2 3 4 3 3 4 3 1 3 3 6 1 7 2														
PREM	1 2 13 5 5 3 10 3 5 5 7 2 1 0 1 6														
RSV	6 6 8 12 6 9 5 9 7 7 8 5 4 3 3 12														

DOT (D,E,F,H)

PREM (P,V,Q,J)

RSV (R,S)

Total OT Forecast vs OT Actual by Category



Total by Seat

5:05 am

Base
AllSeat
All

Legend

- RSV_CURRENT (Orange)
- OT_ASSIGNED (Blue)
- OT_CURRENT (Red)
- OT_FORECAST (Green Dashed)

FCST	12	13	23	16	24	22	18	19	18	17	27	17	13	8	21	21	18	11	22	17	196	160
OTA	8	9	23	20	15	15	18	16	15	13	18	12	11	4	11	20	15	4	19	14	153	127
OT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

<---- Forecast
vs Actual

OT_AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R_AM	0	1	0	0	2	0	3	3	2	1	1	6	1	2	8	2	1	2	2	4	20	21

OT_PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R_PM	1	2	1	6	5	4	0	3	3	5	1	1	3	4	7	2	2	5	1	1	24	33

DOT	1	1	2	3	4	3	3	4	3	1	3	3	6	1	7	2	1	0	3	3	33	21
PREM	1	2	13	5	5	3	10	3	5	5	7	3	1	0	1	6	8	0	6	2	57	29
RSV	6	6	8	12	6	9	5	9	7	7	8	6	4	3	3	12	6	4	10	9	63	77

Notes:

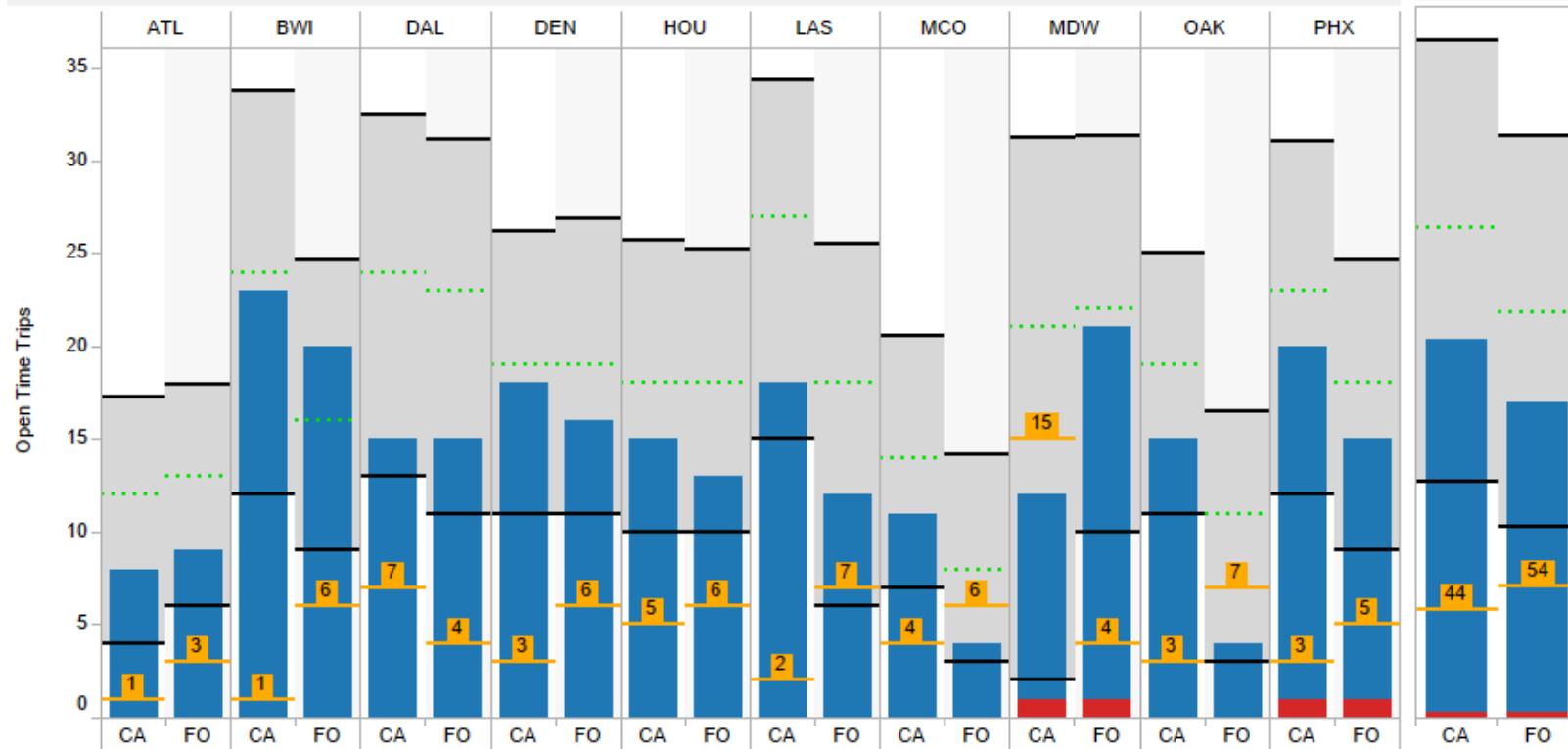
FCST = FORECAST OT
(updates daily)

OTA = OT Assign

OT = OT Current

R = Avail Rsv Blk
(updates hourly)DOT (D,E,F,H)
PREM (P,V,Q,J)
RSV (R,S)

Total OT Forecast vs OT Actual by Category



Total by Seat

6:01 am

Base
AllSeat
All

Legend

- RSV_CURRENT
- OT_ASSIGNED
- OT_CURRENT
- OT_FORECAST

FCST	12	13	23	16	24	22	18	19	18	17	27	17	13	8	21	21	18	11	22	17	196	160
OTA	8	9	23	20	15	15	18	16	15	13	18	12	11	4	11	20	15	4	19	14	153	127
OT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	1	2	2

<---- Forecast
vs Actual

Open Time vs Available Reserves (AM/PM)

OT_AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1
R_AM	0	1	0	0	2	0	3	3	2	1	1	6	1	2	8	2	1	2	2	4	20	21	
OT_PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	1
R_PM	1	2	1	6	5	4	0	3	3	5	1	1	3	4	7	2	2	5	1	1	24	33	

Total by Seat

Notes:
FCST = FORECAST OT
(updates daily)

OTA = OT Assign

OT = OT Current

R = Avail Rsv Blk
(updates hourly)

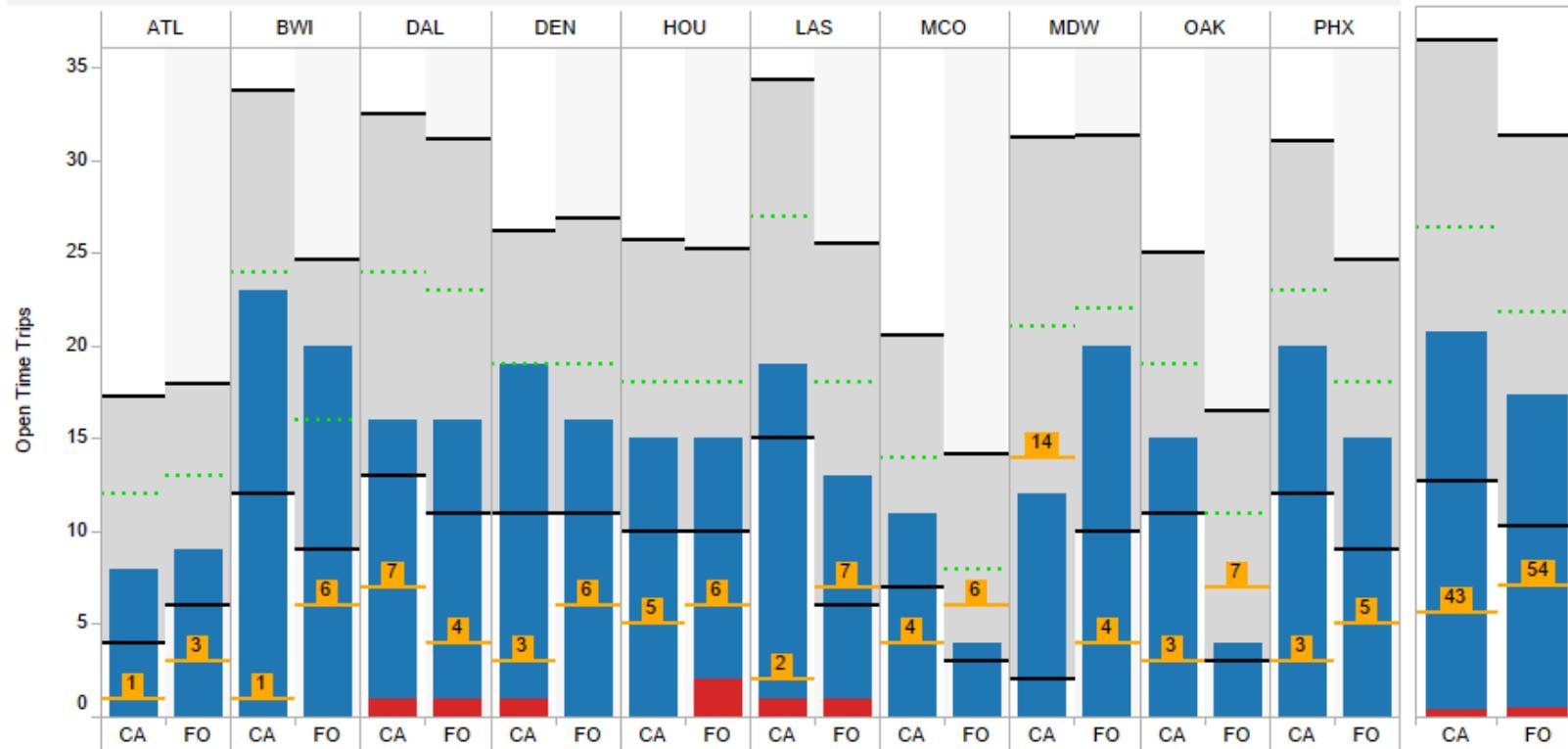
OT Assignments by Label

DOT	1	1	2	3	4	3	3	4	3	1	3	3	6	1	7	2	1	0	3	3	33	21
PREM	1	2	13	5	5	3	10	3	5	5	7	3	1	0	1	6	8	0	6	2	57	29
RSV	6	6	8	12	6	9	5	9	7	7	8	6	4	3	3	12	6	4	10	9	63	77

Total by Seat

DOT (D,E,F,H)
PREM (P,V,Q,J)
RSV (R,S)

Total OT Forecast vs OT Actual by Category



Total by Seat

7:03 am

Base
AllSeat
All

Legend

- RSV_CURRENT (Orange)
- OT_ASSIGNED (Blue)
- OT_CURRENT (Red)
- OT_FORECAST (Green Dashed)

FCST	12	13	23	16	24	22	18	19	18	17	27	17	13	8	21	21	18	11	22	17	196	160
OTA	8	9	23	20	15	15	18	16	15	13	18	12	11	4	12	20	15	4	20	15	155	128
OT	0	0	0	0	1	1	1	0	0	2	1	1	0	0	0	0	0	0	0	0	3	4

<---- Forecast
vs Actual

	Open Time vs Available Reserves (AM/PM)															Total by Seat		
OT_AM	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	1	
R_AM	0	1	0	0	2	0	3	3	2	1	1	6	1	2	8	2	20	21

	OT_ASSIGNMENT by Label															Total by Seat				
DOT	1	1	2	3	4	3	3	4	3	1	3	3	6	1	8	2	1	0	3	3
PREM	1	2	13	5	5	3	10	3	5	5	7	3	1	0	1	6	8	0	7	3
RSV	6	6	8	12	6	9	5	9	7	7	8	6	4	3	3	12	6	4	10	9

Notes:

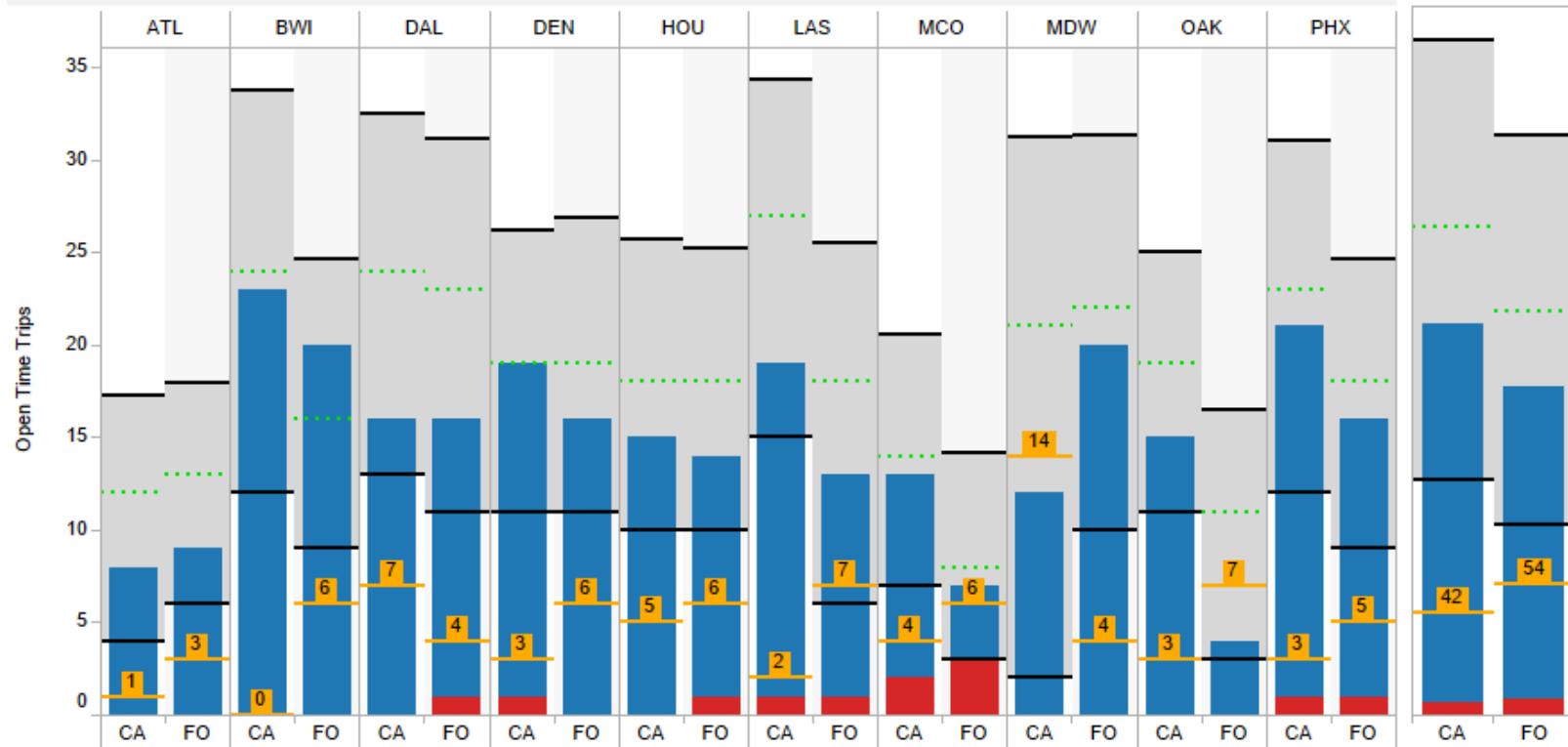
FCST = FORECAST OT
(updates daily)

OTA = OT Assign

OT = OT Current

R = Avail Rsv Blk
(updates hourly)DOT (D,E,F,H)
PREM (P,V,Q,J)
RSV (R,S)

Total OT Forecast vs OT Actual by Category



	<---- Forecast vs Actual														
FCST	12 13 23 16 24 22 18 19 18 17 27 17 13 8 21 21 18 11 22 17														
OTA	8 9 23 20 16 15 18 16 15 13 18 12 11 4 12 20 15 4 20 15														
OT	0 0 0 0 0 1 1 0 0 1 1 2 3 0 0 0 0 1 1 5 7														

Open Time vs Available Reserves (AM/PM)

	Total by Seat														
OT_AM	0 0 0 0 0 1 0 0 0 0 1 1 0 0 0 0 0 0 0														
R_AM	0 1 0 0 2 0 3 3 2 1 1 6 1 2 8 2 1 2 2 4														
OT_PM	0 0 0 0 0 0 1 0 0 1 1 1 1 2 0 0 0 0 1 1														
R_PM	1 2 0 6 5 4 0 3 3 5 1 1 3 4 6 2 2 5 1 1														

OT Assignments by Label

	Total by Seat														
DOT	1 1 2 3 5 3 3 4 3 1 3 3 6 1 8 2 1 0 3 3														
PREM	1 2 13 5 5 3 10 3 5 5 7 3 1 0 1 6 8 0 7 3														
RSV	6 6 8 12 6 9 5 9 7 7 8 6 4 3 3 12 6 4 10 9														

Base All
Seat All

Legend
█ RSV_CURRENT
█ OT_ASSIGNED
█ OT_CURRENT
█ OT_FORECAST

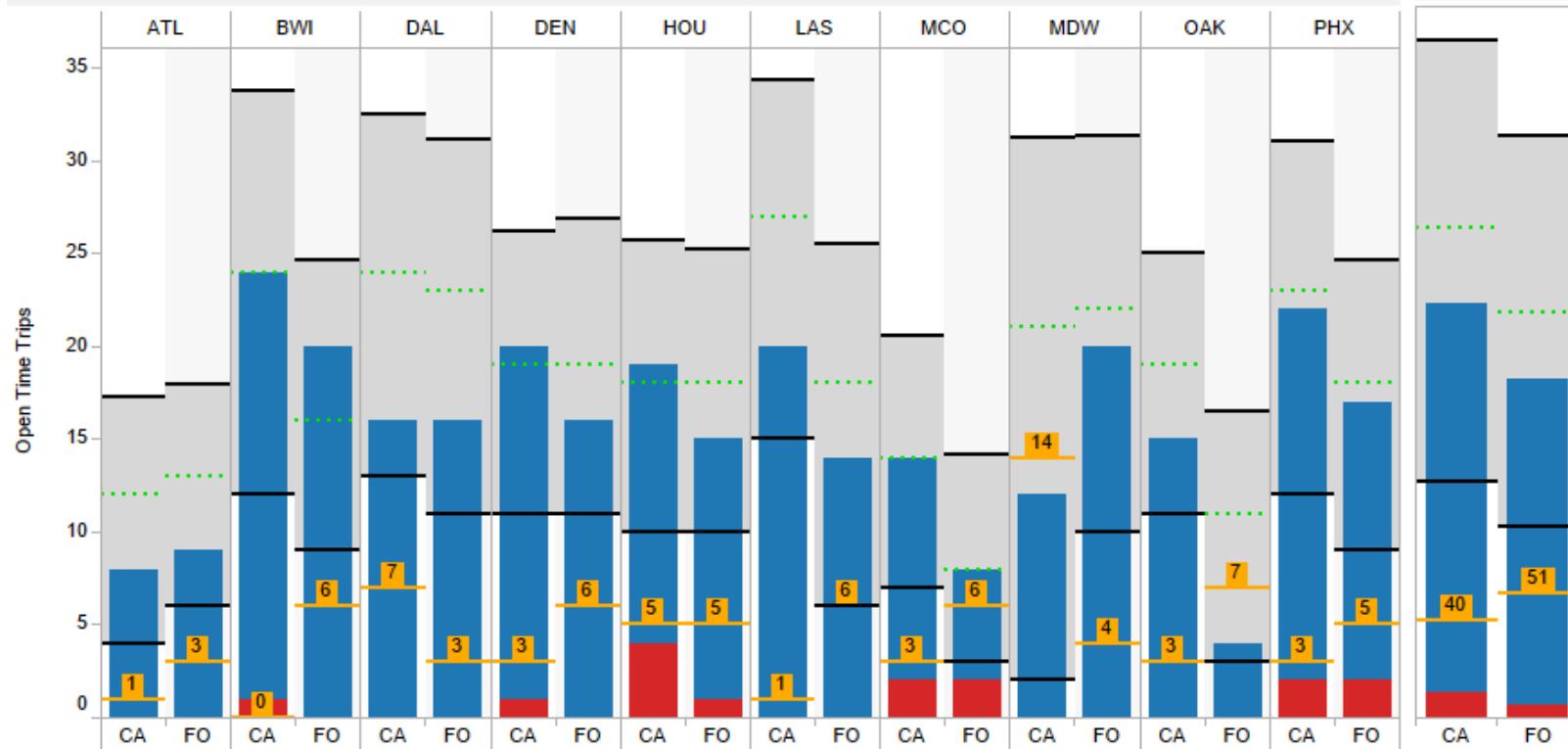
<---- Forecast vs Actual

Notes:
 FCST = FORECAST OT (updates daily)

OTA = OT Assign
 OT = OT Current
 R = Avail Rsv Blk (updates hourly)

DOT (D,E,F,H)
 PREM (P,V,Q,J)
 RSV (R,S)

Total OT Forecast vs OT Actual by Category



Total by Seat

9:02 am

Base
AllSeat
All

Legend

- RSV_CURRENT
- OT_ASSIGNED
- OT_CURRENT
- OT_FORECAST

FCST	12	13	23	16	24	22	18	19	18	17	27	17	13	8	21	21	18	11	22	17	196	160
OTA	8	9	23	20	16	16	19	16	15	14	20	14	12	6	12	20	15	4	20	15	160	134
OT	0	0	1	0	0	0	1	0	4	1	0	0	2	2	0	0	0	0	2	2	10	5

<---- Forecast
vs Actual

Open Time vs Available Reserves (AM/PM)

OT_AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R_AM	0	1	0	0	2	0	3	3	2	1	1	5	1	2	8	2	1	2	2	4	20	20
OT_PM	0	0	1	0	0	0	1	0	4	1	0	0	2	2	0	0	0	0	2	2	10	5
R_PM	1	2	0	6	5	3	0	3	3	4	0	1	2	4	6	2	2	5	1	1	20	31

Total by Seat

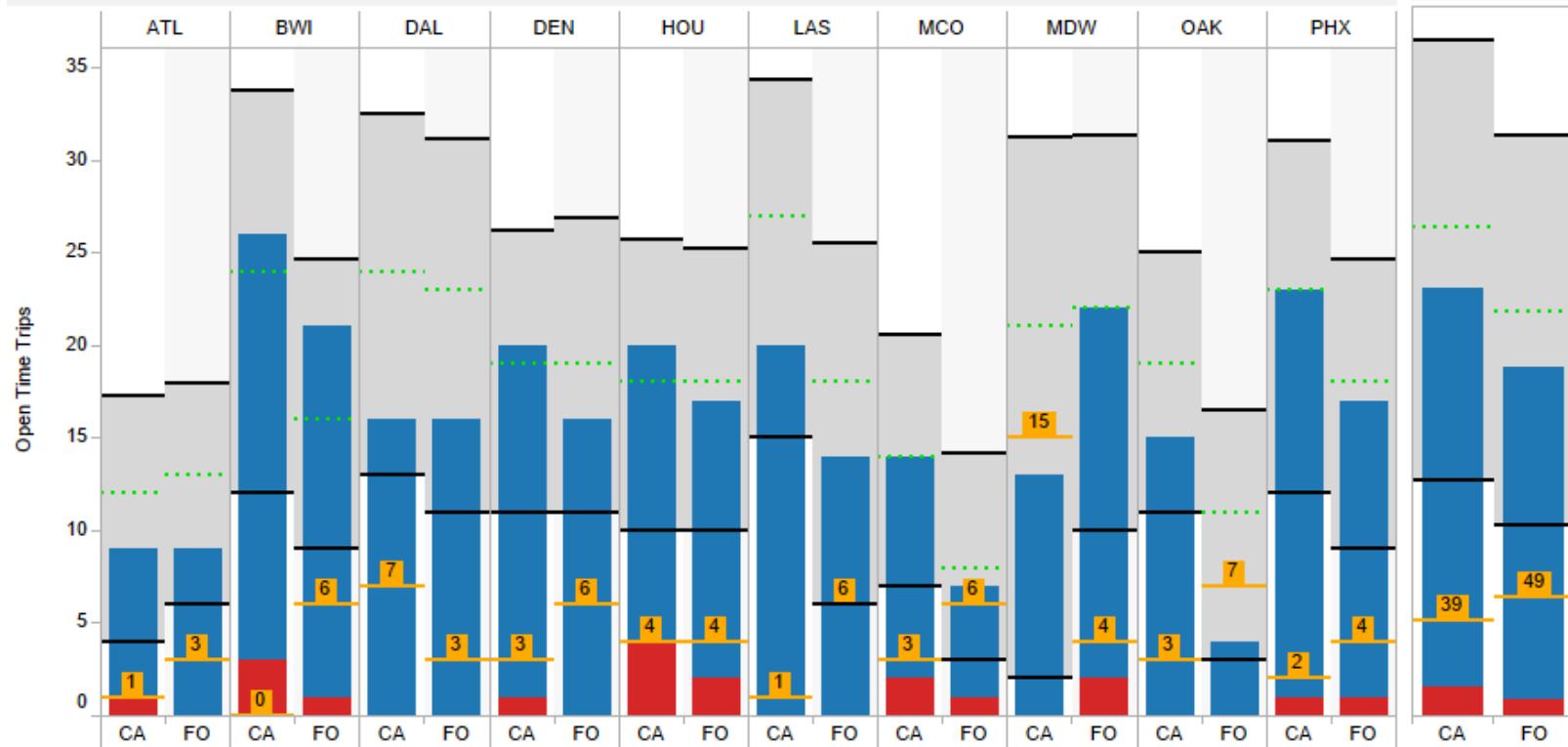
Notes:
 FCST = FORECAST OT
 (updates daily)
 OTA = OT Assign
 OT = OT Current
 R = Avail Rsv Blk
 (updates hourly)

DOT	1	1	2	3	5	4	4	4	3	1	3	3	7	3	8	2	1	0	3	3	37	24
PREM	1	2	13	5	5	3	10	3	5	5	8	4	1	0	1	6	8	0	7	3	59	31
RSV	6	6	8	12	6	9	5	9	7	8	9	7	4	3	3	12	6	4	10	9	64	79

Total by Seat

DOT (D,E,F,H)
 PREM (P,V,Q,J)
 RSV (R,S)

Total OT Forecast vs OT Actual by Category



Total by Seat

10:01 am

Base
AllSeat
All

Legend

- RSV_CURRENT
- OT_ASSIGNED
- OT_CURRENT
- OT_FORECAST

FCST	12	13	23	16	24	22	18	19	18	17	27	17	13	8	21	21	18	11	22	17	196	160
OTA	8	9	23	20	16	16	19	16	16	15	20	14	12	6	13	20	15	4	22	16	164	136
OT	1	0	3	1	0	0	1	0	4	2	0	0	2	1	0	2	0	0	1	1	12	7

<---- Forecast
vs Actual

Open Time vs Available Reserves (AM/PM)

OT_AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R_AM	0	1	0	0	2	0	3	3	1	0	1	5	1	2	8	2	1	2	1	3	18	18
OT_PM	1	0	3	1	0	0	1	0	4	2	0	0	2	1	0	2	0	0	1	1	12	7
R_PM	1	2	0	6	5	3	0	3	3	4	0	1	2	4	7	2	2	5	1	1	21	31

Total by Seat

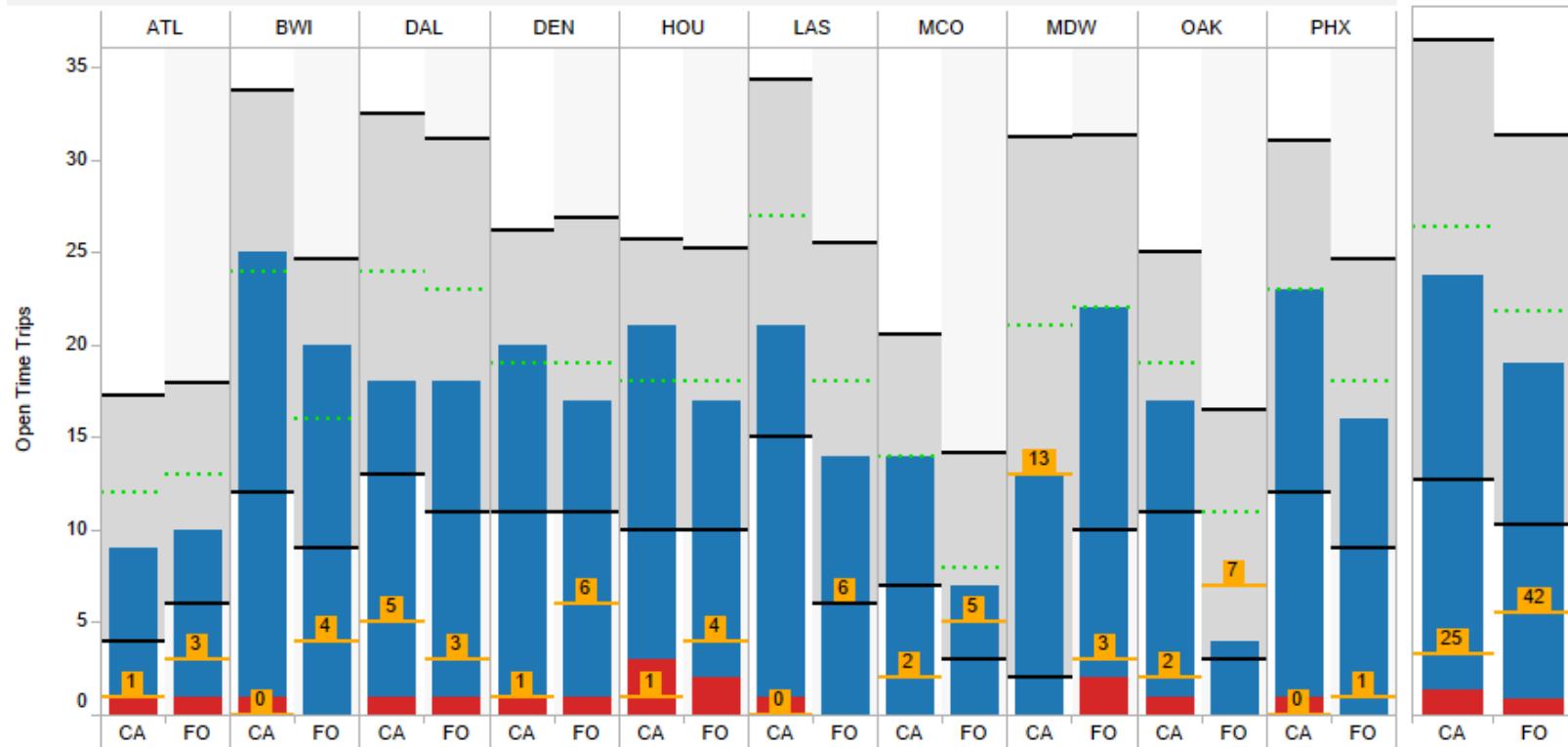
Notes:
 FCST = FORECAST OT
 (updates daily)
 OTA = OT Assign
 OT = OT Current
 R = Avail Rsv Blk
 (updates hourly)

OT Assignments by Label

DOT	1	1	2	3	5	4	4	4	3	1	3	3	7	3	10	2	1	0	3	3	39	24
PREM	1	2	13	5	5	3	10	3	5	5	8	4	1	0	1	6	8	0	8	3	60	31
RSV	6	6	8	12	6	9	5	9	8	9	9	7	4	3	2	12	6	4	11	10	65	81

DOT (D,E,F,H)
 PREM (P,V,Q,J)
 RSV (R,S)

Total OT Forecast vs OT Actual by Category



Total by Seat

11:02 am

 Base
All

 Seat
All

Legend

- RSV_CURRENT (Orange)
- OT_ASSIGNED (Blue)
- OT_CURRENT (Red)
- OT_FORECAST (Green Dashed)

	FCST	OTA	OT															
FCST	12	8	1	13	9	1	23	24	1	16	20	0	24	17	1	19	19	1
OTA	8	24	1	9	20	1	17	17	1	16	16	0	18	18	1	15	15	2
OT	1	1	1	1	1	1	1	17	1	1	17	0	22	21	0	22	20	1

 <---- Forecast
vs Actual

	OT_AM	R_AM	OT_AM	R_AM	OT_AM	R_AM	OT_AM	R_AM	OT_AM	OT_AM	R_AM	OT_AM	OT_AM	R_AM	OT_AM	OT_AM	R_AM
OT_AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R_AM	0	1	0	0	0	0	1	3	0	0	0	5	1	1	7	1	0

Total by Seat

Notes:

 FCST = FORECAST OT
(updates daily)

	OT_PM	R_PM	OT_PM	R_PM	OT_PM	R_PM	OT_PM	R_PM	OT_PM	OT_PM	R_PM	OT_PM	OT_PM	R_PM	OT_PM	OT_PM	R_PM	
OT_PM	1	1	1	0	1	1	1	1	3	2	1	0	0	0	2	1	0	
R_PM	1	2	0	4	5	3	0	3	1	4	0	1	1	4	6	2	2	5

Total by Seat

10 7

	OT Assignments by Label																Total by Seat	
	DOT	PREM	RSV	DOT	PREM	RSV	DOT	PREM	RSV	DOT	PREM	RSV	DOT	PREM	RSV	DOT	PREM	RSV
DOT	1	1	3	3	6	4	4	4	3	1	3	3	9	3	10	2	1	0
PREM	1	2	13	5	5	4	10	3	5	5	8	4	1	1	1	6	8	3
RSV	6	6	8	12	6	9	5	9	10	9	9	7	4	3	2	12	7	4
	43	24	68	24	60	33	43	24	68	81								

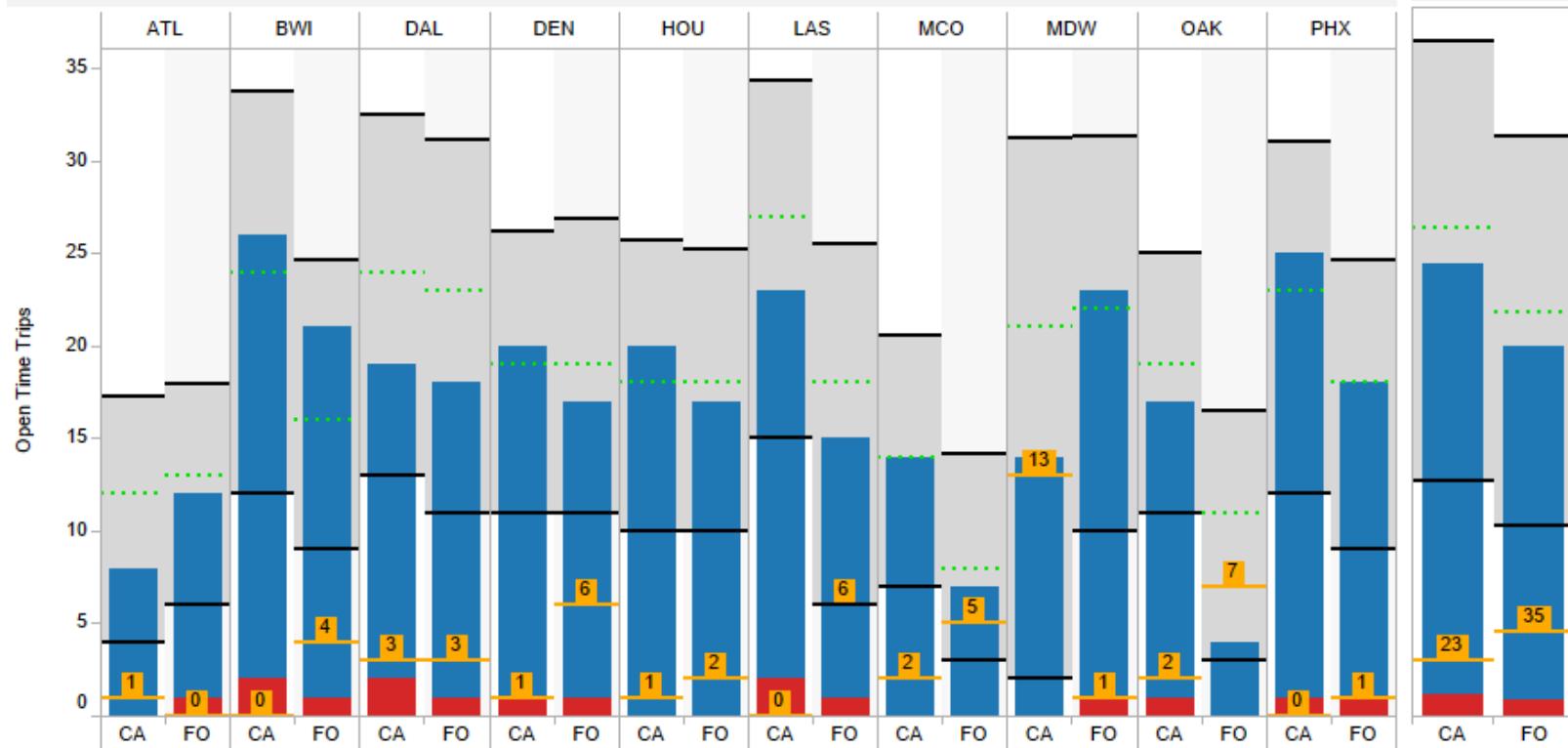
 DOT (D,E,F,H)
PREM (P,V,Q,J)
RSV (R,S)

43 24

60 33

68 81

Total OT Forecast vs OT Actual by Category



Total by Seat

12:01 pm

Base
AllSeat
All

Legend

- RSV_CURRENT
- OT_ASSIGNED
- OT_CURRENT
- OT_FORECAST

FCST	12	13	23	16	24	22	18	19	18	17	27	17	13	8	21	21	18	11	22	17	196	160
OTA	8	11	24	20	17	17	19	16	20	17	21	14	14	7	14	22	16	4	24	17	177	145
OT	0	1	2	1	2	1	1	1	0	0	2	1	0	0	0	1	1	0	1	1	9	7

<---- Forecast
vs Actual

Open Time vs Available Reserves (AM/PM)															Total by Seat		
OT_AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R_AM	0	0	0	0	0	0	1	3	1	0	0	5	1	1	7	1	0

Notes:

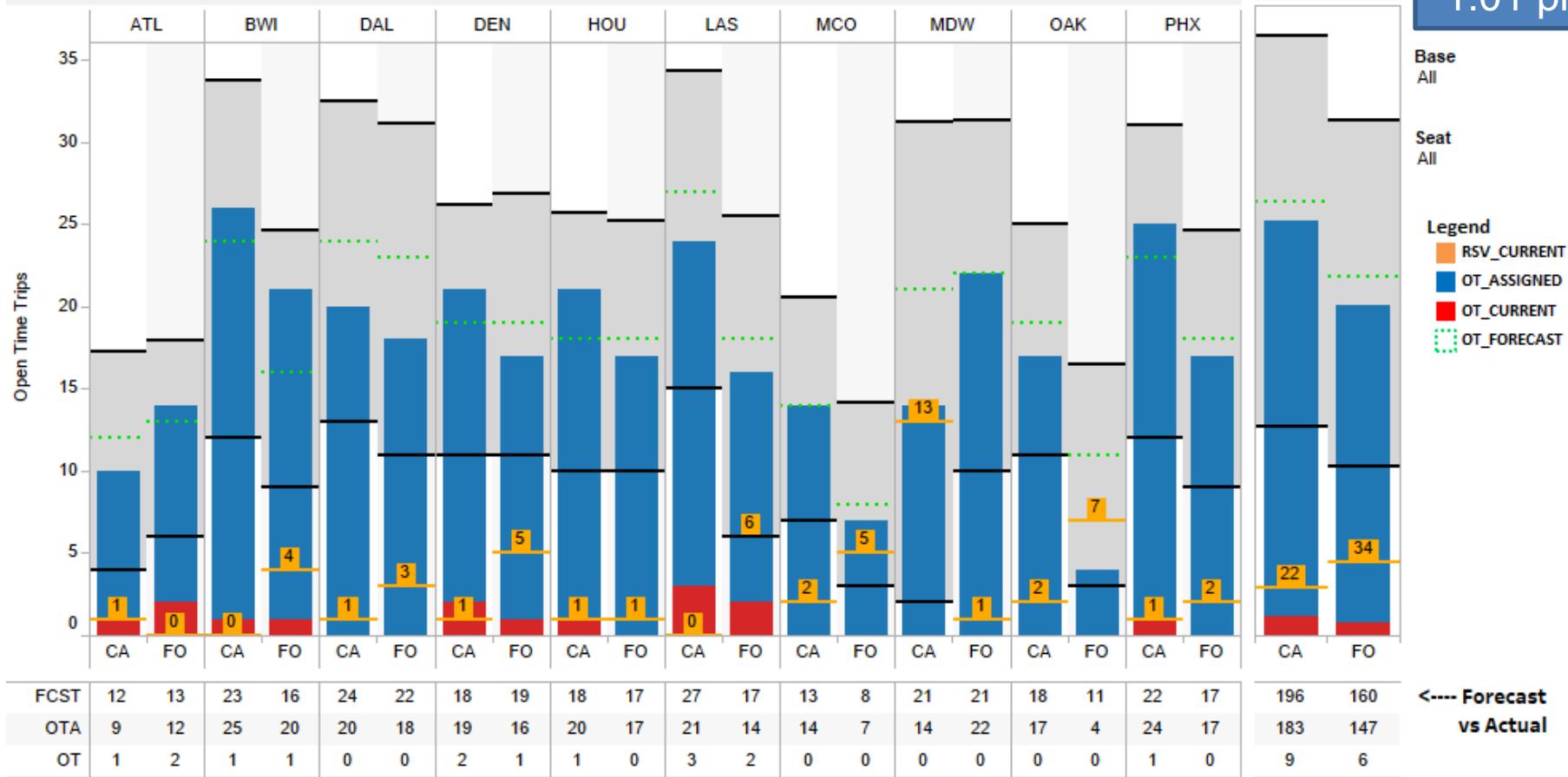
FCST = FORECAST OT
(updates daily)

OT_ASSIGNMENTS by Label															Total by Seat							
DOT	1	1	3	3	6	4	4	4	3	1	3	3	9	3	11	2	1	0	4	4	45	25
PREM	1	3	13	5	5	4	10	3	6	5	8	4	1	1	1	6	8	0	8	3	61	34
RSV	6	7	8	12	6	9	5	9	11	11	10	7	4	3	2	14	7	4	12	10	71	86

DOT (D,E,F,H)
PREM (P,V,Q,J)
RSV (R,S)

Total by Seat

Total OT Forecast vs OT Actual by Category



Open Time vs Available Reserves (AM/PM)

	OT_AM	R_AM	OT_PM	R_PM																
OT_AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R_AM	0	0	0	0	0	0	1	3	1	0	0	5	1	1	7	1	0	2	1	1
OT_PM	1	2	1	1	0	0	2	1	1	0	3	2	0	0	0	0	0	0	1	0
R_PM	1	0	0	4	1	3	0	2	0	1	0	1	1	4	6	0	2	5	0	1

OT Assignments by Label

	DOT	PREM	RSV																	
DOT	1	1	3	3	6	5	4	3	3	1	3	3	9	3	11	2	2	0	5	4
PREM	1	3	14	5	5	4	10	3	6	5	8	4	1	1	1	6	8	0	8	4
RSV	7	8	8	12	9	9	5	10	11	11	10	7	4	3	2	14	7	4	11	9

Total by Seat

1:01 pm

Base
AllSeat
All

Legend

- RSV_CURRENT (Orange)
- OT_ASSIGNED (Blue)
- OT_CURRENT (Red)
- OT_FORECAST (Green Dashed)

<---- Forecast
vs Actual

Total by Seat

Notes:
 FCST = FORECAST OT (updates daily)
 OTA = OT Assign
 OT = OT Current
 R = Avail Rsv Blk (updates hourly)

OTA = OT Assign

OT = OT Current

R = Avail Rsv Blk (updates hourly)

DOT (D,E,F,H)

PREM (P,V,Q,J)

RSV (R,S)

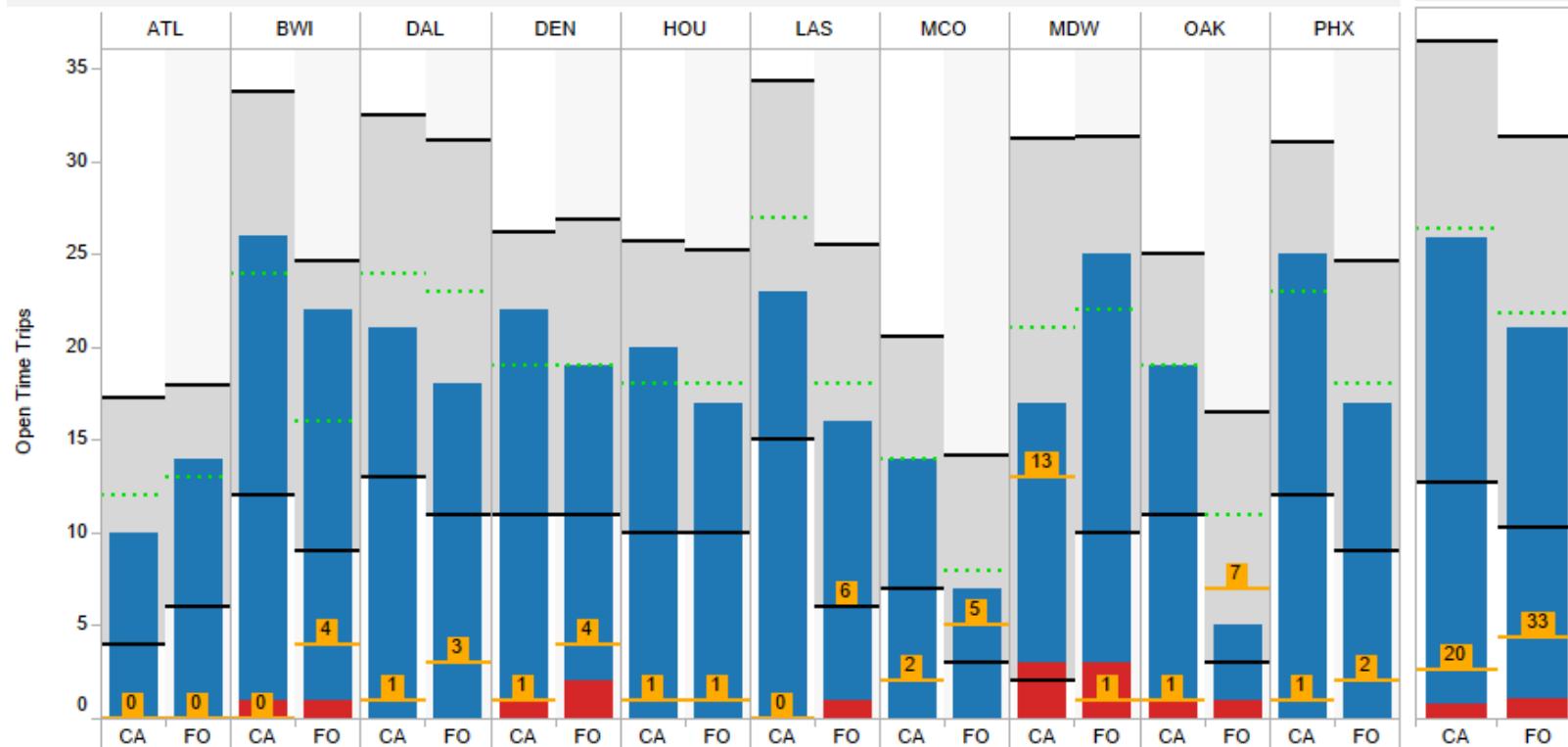
Total by Seat

47 25

62 35

74 87

Total OT Forecast vs OT Actual by Category



2:01 pm

Total by Seat

Base
AllSeat
All

Legend

- RSV_CURRENT
- OT_ASSIGNED
- OT_CURRENT
- OT_FORECAST

FCST	12	13	23	16	24	22	18	19	18	17	27	17	13	8	21	21	18	11	22	17	196	160
OTA	10	14	25	21	21	18	21	17	20	17	23	15	14	7	14	22	18	4	25	17	191	152
OT	0	0	1	1	0	0	1	2	0	0	0	1	0	0	3	3	1	1	0	0	6	8

<---- Forecast
vs Actual

Open Time vs Available Reserves (AM/PM)

OT_AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R_AM	0	0	0	0	0	0	1	3	1	0	0	5	1	1	7	1	0	2	1	1	11	13
OT_PM	0	0	1	1	0	0	1	2	0	0	0	1	0	0	3	3	1	1	0	0	6	8
R_PM	0	0	0	4	1	3	0	1	0	1	0	1	1	4	6	0	1	5	0	1	9	20

Total by Seat

Notes:
FCST = FORECAST OT
(updates daily)

OTA = OT Assign

OT = OT Current

R = Avail Rsv Blk
(updates hourly)

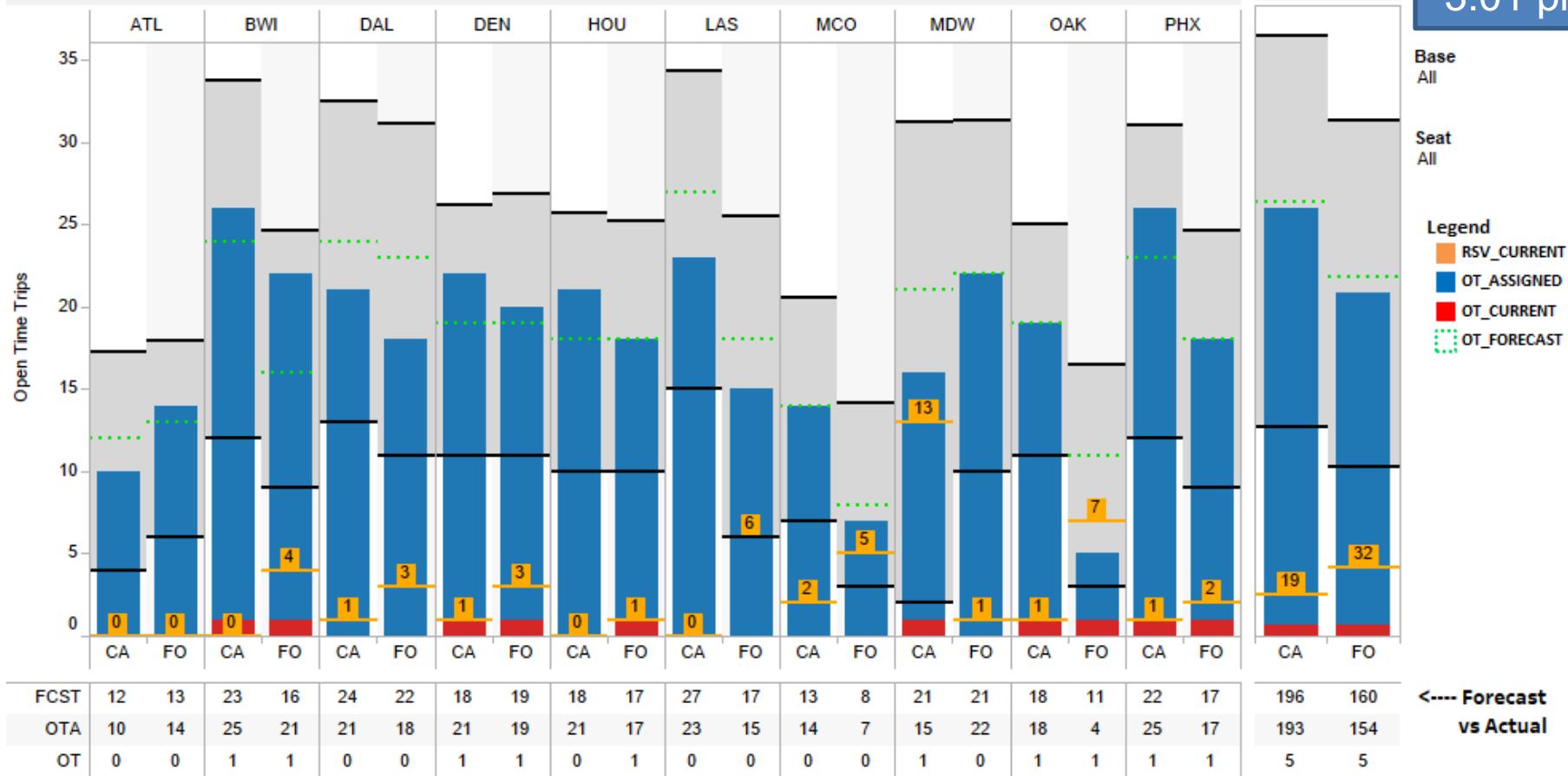
OT Assignments by Label

DOT	1	1	3	3	6	5	5	3	3	1	4	4	9	3	11	2	2	0	5	4	49	26
PREM	1	4	14	5	5	4	11	3	6	5	9	4	1	1	1	6	8	0	8	4	64	36
RSV	8	9	8	13	10	9	5	11	11	11	10	7	4	3	2	14	8	4	12	9	78	90

Total by Seat

DOT (D,E,F,H)
PREM (P,V,Q,J)
RSV (R,S)

Total OT Forecast vs OT Actual by Category



Open Time vs Available Reserves (AM/PM)

	Total by Seat															
OT_AM	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0															
R_AM	0 0 0 0 0 0 1 3 0 0 0 5 1 1 7 1 0 2 1 1															
OT_PM	0 0 1 1 0 0 1 1 0 1 0 0 0 0 1 0 1 1 1 1															
R_PM	0 0 0 4 1 3 0 0 0 1 0 1 4 6 0 1 5 0 1															

OT Assignments by Label

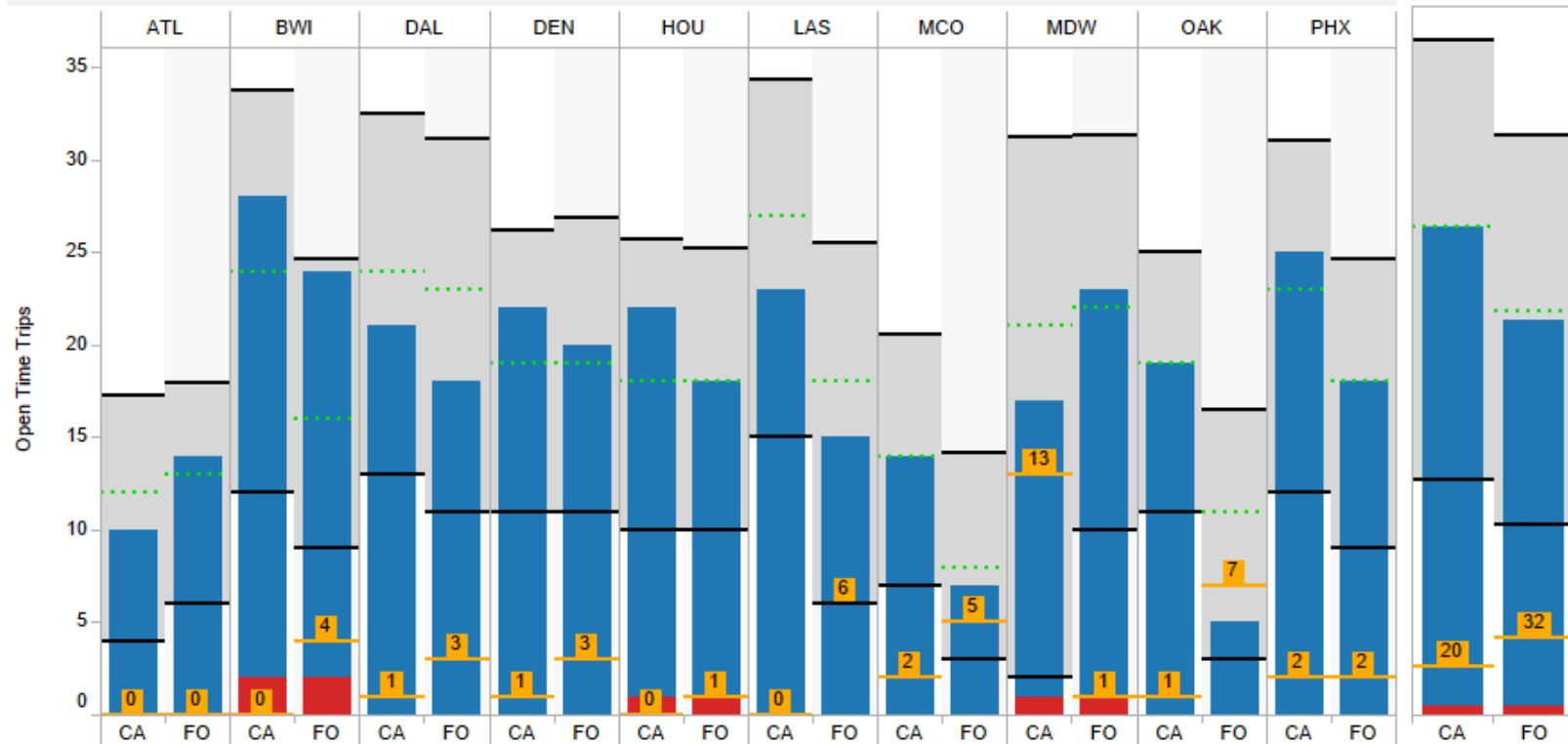
	Total by Seat															
DOT	1 1 3 3 6 5 5 3 3 1 4 4 9 3 11 2 2 0 5 4															
PREM	1 4 14 5 5 4 11 4 7 5 9 4 1 1 2 6 8 0 8 4															
RSV	8 9 8 13 10 9 5 12 11 11 10 7 4 3 2 14 8 4 12 9															

Notes:
FCST = FORECAST OT
(updates daily)

OTA = OT Assign
OT = OT Current
R = Avail Rsv Blk
(updates hourly)

DOT (D,E,F,H)
PREM (P,V,Q,J)
RSV (R,S)

Total OT Forecast vs OT Actual by Category



Total by Seat

4:01 pm

Base
AllSeat
All

Legend

- RSV_CURRENT (Orange)
- OT_ASSIGNED (Blue)
- OT_CURRENT (Red)
- OT_FORECAST (Green Dashed)

<---- Forecast
vs Actual

	FCST	OTA	OT															
FCST	12	10	0	13	14	2	23	26	2	16	21	0	24	21	0	22	197	4
OTA	10	12	0	13	15	0	16	22	0	18	18	0	22	18	0	17	158	0
OT	0	0	2	0	0	0	0	21	0	0	20	1	0	17	1	0	0	0

Open Time vs Available Reserves (AM/PM)

OT_AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R_AM	0	0	0	0	0	0	1	3	0	0	0	5	1	1	7	1	0	2
OT_PM	0	0	2	2	0	0	0	0	1	1	0	0	0	0	1	1	0	0
R_PM	0	0	0	4	1	3	0	0	0	1	0	1	4	6	0	1	5	1

Total by Seat

Notes:
FCST = FORECAST OT
(updates daily)OTA = OT Assign
OT = OT Current
R = Avail Rsv Blk
(updates hourly)

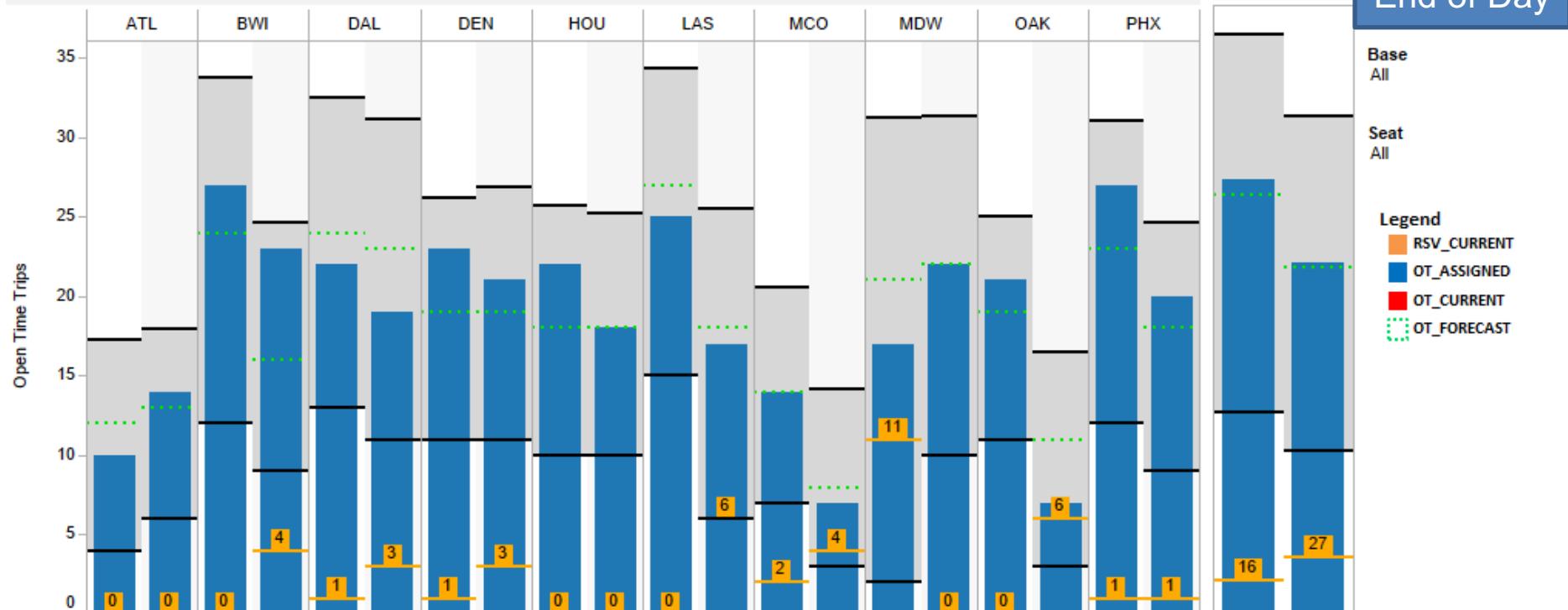
OT Assignments by Label

DOT	1	1	3	3	6	5	5	3	3	1	4	4	9	3	12	2	2	0
PREM	1	4	15	5	5	4	12	5	7	5	9	4	1	1	2	6	9	0
RSV	8	9	8	14	10	9	5	12	11	11	10	7	4	3	2	14	8	5

Total by Seat

DOT (D,E,F,H)
PREM (P,V,Q,J)
RSV (R,S)

Total OT Forecast vs OT Actual by Category



Total by Seat

End of Day

 Base
All

 Seat
All

Legend

- RSV_CURRENT
- OT_ASSIGNED
- OT_CURRENT
- OT_FORECAST

FCST	12	13	23	16	24	22	18	19	18	17	27	17	13	8	21	21	18	11	22	17	196	160
OTA	10	14	27	23	22	19	23	21	22	18	25	17	14	7	17	22	21	7	27	20	208	168
OT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

<---- Forecast
vs Actual

	Open Time vs Available Reserves (AM/PM)																		Total by Seat
OT_AM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R_AM	0	0	0	0	0	0	1	3	0	0	0	5	1	1	6	0	0	2	1

Notes:

FCST = FORECAST OT
(updates daily)

	OT_ASSIGNMENTS by Label																		Total by Seat
DOT	1	1	3	3	6	5	5	3	3	1	4	4	9	3	12	2	2	0	5
PREM	1	4	16	5	6	5	13	6	8	5	11	6	1	1	2	6	10	1	9
RSV	8	9	8	15	10	9	5	12	11	12	10	7	4	3	3	14	9	6	13

DOT (D,E,F,H)
PREM (P,V,Q,J)
RSV (R,S)

50 26
77 45
81 97

16 27
1 1
7 15

0 0
9 12

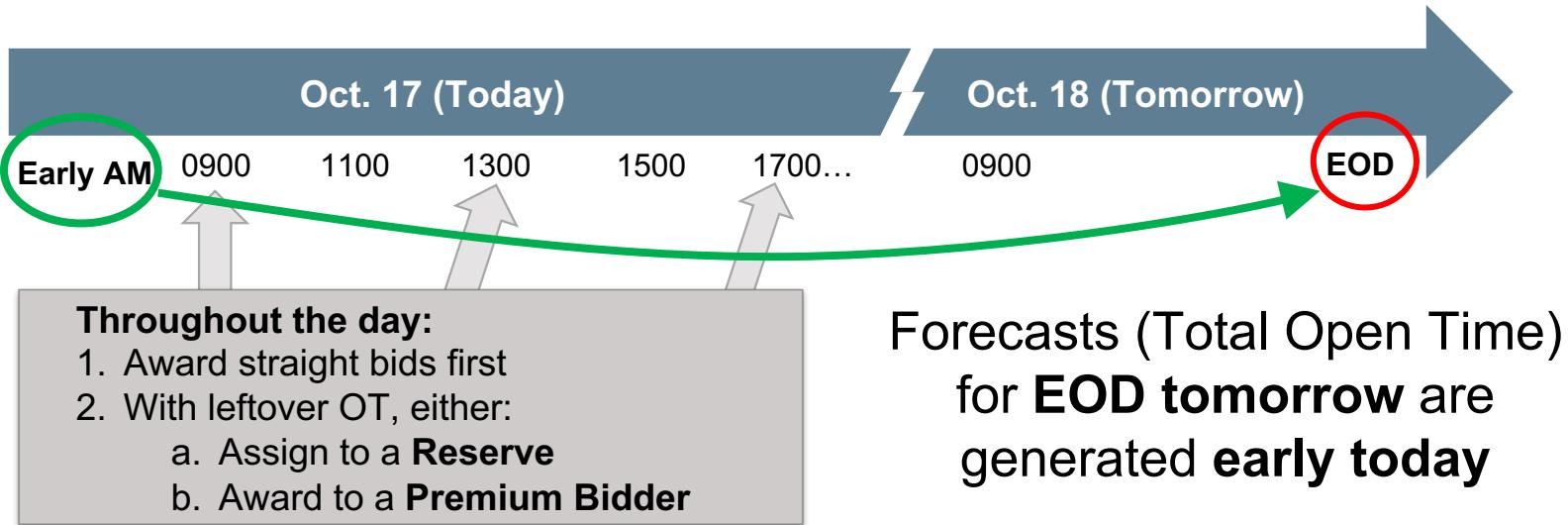
How Can Data Science Help?

After working with the user to understand the Business Problem, we decided providing forecasts for the key resources used by Crew Schedulers could help produce cost savings benefits for Southwest Airlines *without any change to the user's business process.*

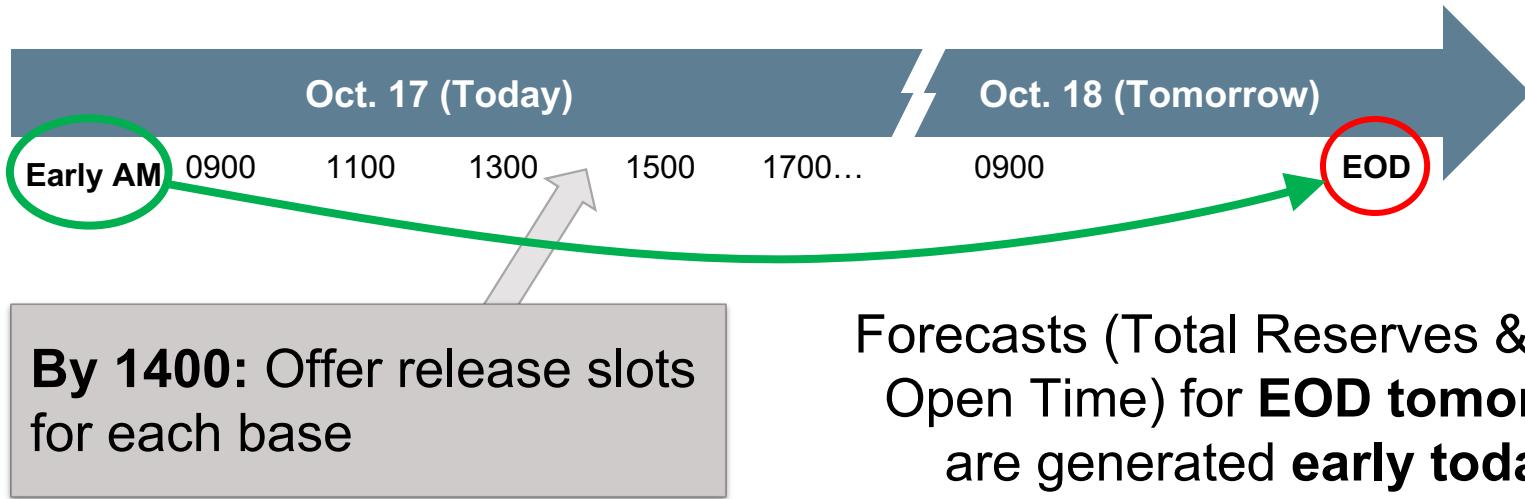
Crew Scheduling Business Process

Making OT Assignment Decisions Today for Tomorrow's Flight Schedule

Business Process – Pilots (scarce Reserves)



Business Process – Flight Attendants (surplus Reserves)



DataScience@SMU

Data

The “Fuel” for Effective Models

Data Sources – My Tool (Alteryx)

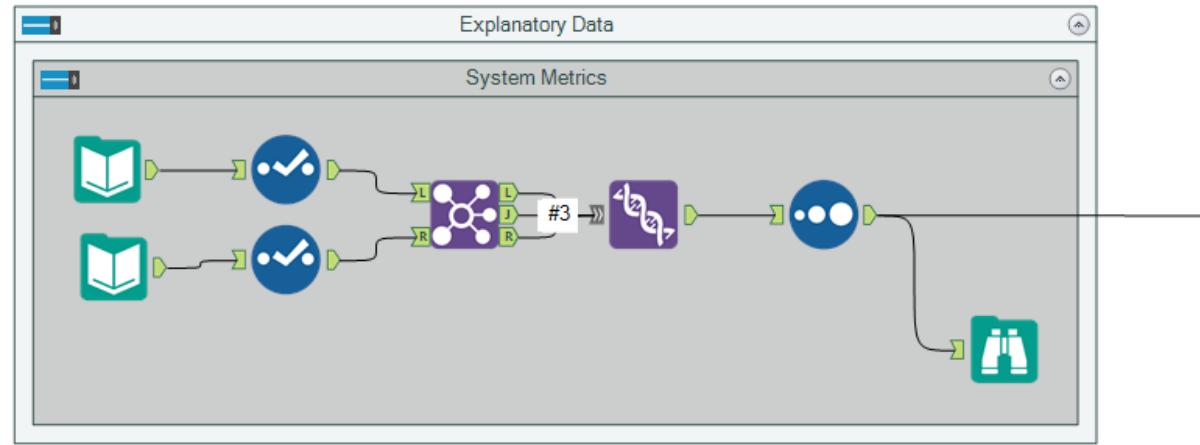
Could use R or Python (should know!) but a Tool can be very helpful

alteryx



Basic Intro to Alteryx

System Metrics.
Since 2015-01-01

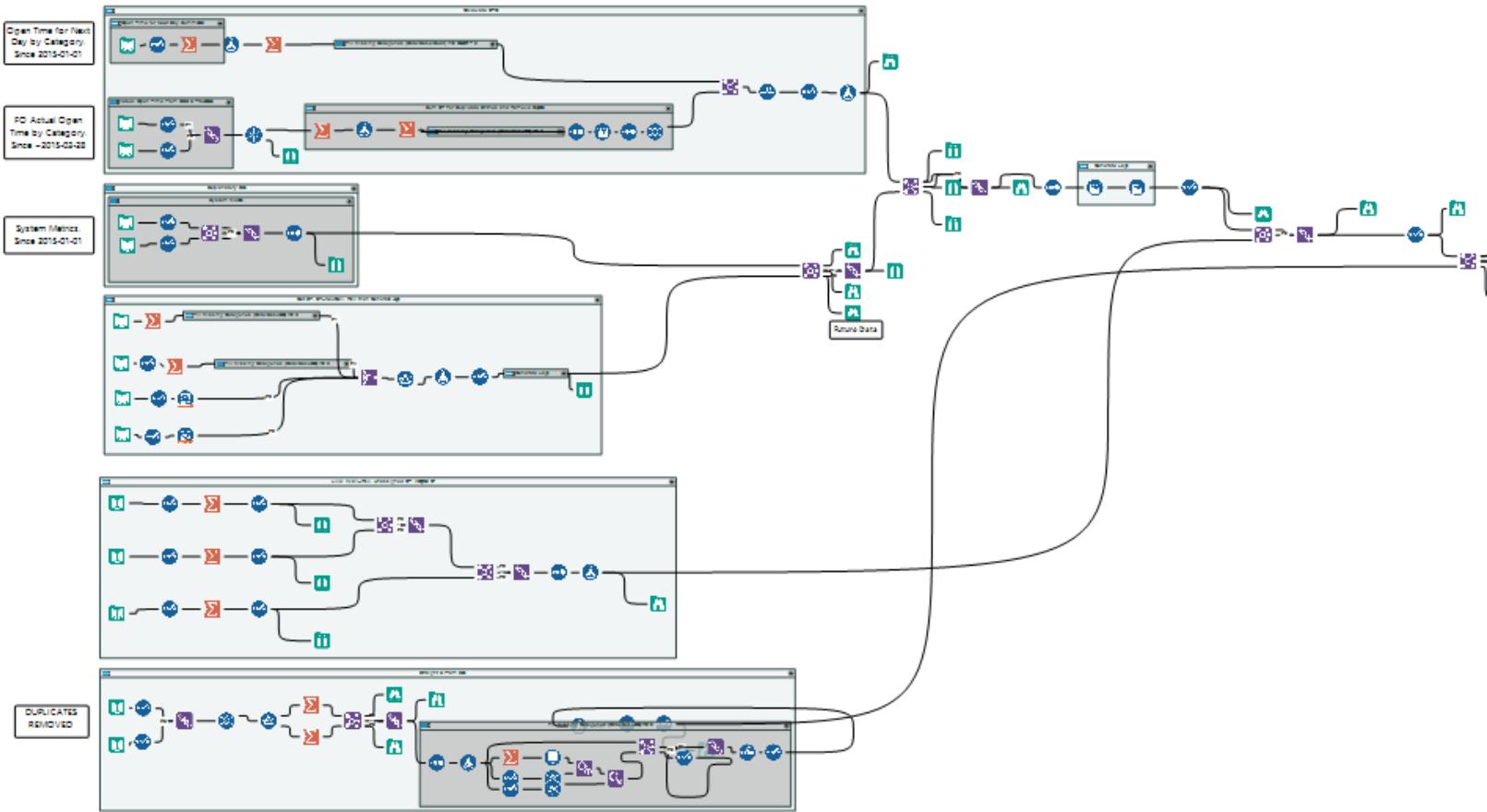


1. Pull data from database (SQL)
2. Select desired fields and set data names/types
3. Full Outer Join two data sets
4. Sort Data
5. View Data

Data Gathering with Alteryx

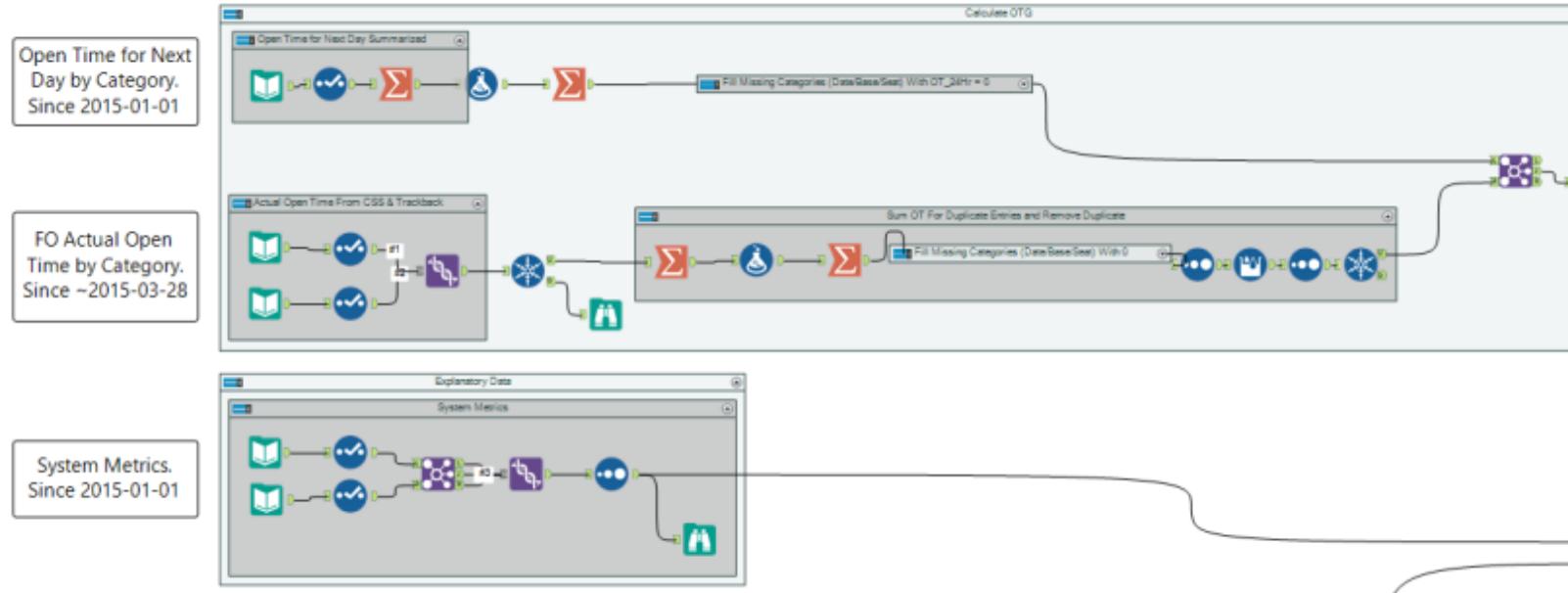
alteryx

14 Queries &
2 Databases



Data Gathering with Alteryx

alteryx



Leveraged existing, robust queries

Data - Historical

Start simple – Don’t pull all available data right away

- Avoid “Kitchen-Sink Modeling”; also “Data Dredging”
- If the problem can be expressed as a Time Series, start by pulling univariate data for the expected target variable
- Work with Business “SME”s to ensure the data points are accurate and trusted by Business Users
 - If User’s cannot trust the data you’re using, they will not trust your Model either

Data Profiling & Considerations

- How far back historically can we pull data? Is it still representative of the Users current Business Problem?
- Seek source data

Data - Operational

Defined & constrained by the specific business problem

- Discover operational (or run-time) data constraints for the model:
 - When do the forecasts need to be provided?
 - How long can the model take to run (maximum)?
 - How often will the model need to run?
 - What kind of system is the model running on?
 - Multi-threaded/optimized? Personal Machine? Alteryx Gallery?
 - How quickly does the User need a model/forecast for their work? I.e. How long do you have to research and build a model?
 - Are there any constraints associated with the source database?
 - Only daily aggregations available? Live-feed of data available?
 - Consider Permissions/SLAs for the source data
 - I.e. what happens with your model if the source data is not available? Are the Users able to still perform the business process?

DataScience@SMU

Modeling

Initial Models

Mean: forecasts of all future values are equal to the mean of the historical data

Naïve: forecasts equal to the last observed value

Seasonal Naïve: forecasts equal to last value from same season (season can be user defined: month, quarter, etc.)

Linear Regression: models the relationship between a dependent variable and one or more independent variables (Sick lags, holiday indicator, Reserve duty available, Duty Period amount)

ARIMA: applies autoregressive integrated moving average models to find the best fit of a time-series model to past values of a time series

ARIMA with Regressors: in addition to lag and error values, explanatory variables are integrated to the model

Time Series Linear Regression: fits linear models to time series, including trend and seasonality components as well as independent variables

Exponential Smoothing: weighs past observations with exponentially decreasing weights as we go back in time to forecast future values. In essence, more weight is given to the more recent observations

Neural Network: Neural Network assumes that the function to predict future values need not be linear. NN can be thought of as a sort of non-linear (auto) regression model, where a hidden layer of nodes are connected to the explanatory variables (input). These nodes then perform transformations of the input variables and produce an output (predicted value).

Modeling

Developing a Baseline Model

Seasonal Naive

Definition: forecasts equal to last value from same season
(season can be user defined: month, quarter, etc.)

- Used as a **baseline forecast**: this method is similar to what schedulers would do: “What happened *last Thursday*? ”
- Seasonal Naïve Method (Weekly): use *last week’s* value as a forecast for tomorrow.

Seasonal Naive

Turns out, the error here is really bad

What happened last Thursday has no material affect on the operations (excluding individual scheduler decisions). However, assignment decisions made over the prior few days can affect the forecast day (trip length greater than 2 days).

So, what should we use as a Baseline Model?

Univariate ARIMA

Definition: Forecasts the future values of a series based entirely on its own historical values

- Used as a **baseline forecast** – what kind of error can we get with no other information added to the model

We want to develop a model that has consistently less error than this model's forecast.

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Modeling

Improving on the Baseline Model

Multivariate ARIMA

Definition: Forecasts the future values of a series based on its own historical values as well as additional external regressors

- Used to beat the baseline forecast – adding external regressors to the univariate model should improve its accuracy (with sound regressor selection)

Other Model Considerations

Do other methods give improved error?

Time Series Linear Regression: fits linear models to time series, including trend and seasonality components as well as independent variables

Exponential Smoothing: weighs past observations with exponentially decreasing weights as we go back in time to forecast future values. In essence, more weight is given to the more recent observations

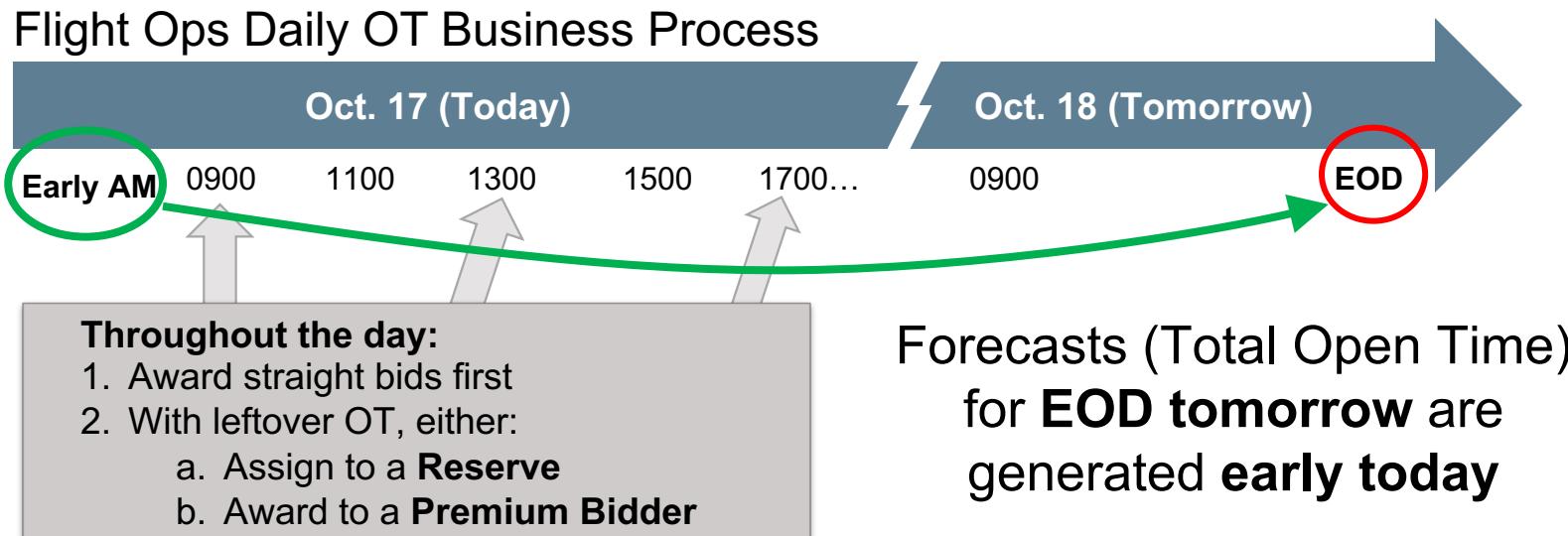
Neural Network: Neural Network assumes that the function to predict future values need not be linear. NN can be thought of as a sort of non-linear (auto) regression model, where a hidden layer of nodes are connected to the explanatory variables (input). These nodes then perform transformations of the input variables and produce an output (predicted value).

Modeling

External Regressor (Variable)
Selection

External Regressors

Regressors must work in the context of the Business Process.
I.e. regressor data must be available at model runtime



External Regressors

An “Extreme Example” to drive the previous point home:

Forecasting Fuel usage for all flights *tomorrow*
vs
Fuel usage for the *next full year*

External Regressors

Some Specific Regressors used in the OT/Rsv models

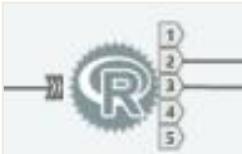
- Reserves available for tomorrow as seen today (at model runtime)
- Crew assigned to a trip who called in sick already for tomorrow, trip does NOT have to start tomorrow but at least span it (referred to as Total Sick)
- Crew assigned to a trip who called in sick already for tomorrow, trip must start tomorrow (referred to as New Sick)
- Crew on a reserve block who called in sick already for tomorrow
- Reserves already ‘used’ or assigned a trip for tomorrow

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Deployment

Providing Forecasts to the
People/System That Uses Them

Leveraging Data within Alteryx (For Data Scientists)



```
write.Alteryx(df, 5)
```

```
AlteryxMessage("Begin Reserve Total Forecast", msg.consts$INFO, priority.consts$LOW )
df[df$Base == "ATL",c("Reserve_Total_Forecast","Reserve_Total_Forecast_Upper", "Reserve_Total_Forecast_Lower")] <- doArimaForecastReg(data[data$Base ==
df[df$Base == "BWI",c("Reserve_Total_Forecast","Reserve_Total_Forecast_Upper", "Reserve_Total_Forecast_Lower")] <- doArimaForecastReg(data[data$Base ==
df[df$Base == "DAL",c("Reserve_Total_Forecast","Reserve_Total_Forecast_Upper", "Reserve_Total_Forecast_Lower")] <- doArimaForecastReg(data[data$Base ==
df[df$Base == "DEN",c("Reserve_Total_Forecast","Reserve_Total_Forecast_Upper", "Reserve_Total_Forecast_Lower")] <- doArimaForecastReg(data[data$Base ==
df[df$Base == "HOU",c("Reserve_Total_Forecast","Reserve_Total_Forecast_Upper", "Reserve_Total_Forecast_Lower")] <- doArimaForecastReg(data[data$Base ==
df[df$Base == "LAS",c("Reserve_Total_Forecast","Reserve_Total_Forecast_Upper", "Reserve_Total_Forecast_Lower")] <- doArimaForecastReg(data[data$Base ==
df[df$Base == "LAX",c("Reserve_Total_Forecast","Reserve_Total_Forecast_Upper", "Reserve_Total_Forecast_Lower")] <- doArimaForecastReg(data[data$Base ==
df[df$Base == "MCO",c("Reserve_Total_Forecast","Reserve_Total_Forecast_Upper", "Reserve_Total_Forecast_Lower")] <- doArimaForecastReg(data[data$Base ==
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df[df$Base == "PHX",c("Reserve_Total_Forecast","Reserve_Total_Forecast_Upper", "Reserve_Total_Forecast_Lower")] <- doArimaForecastReg(data[data$Base ==
```

R Tool allows R code to be used
at any point in the workflow

Allows for utilization of R
packages for forecasts/etc.

Deployment Considerations

Deploying a developed model

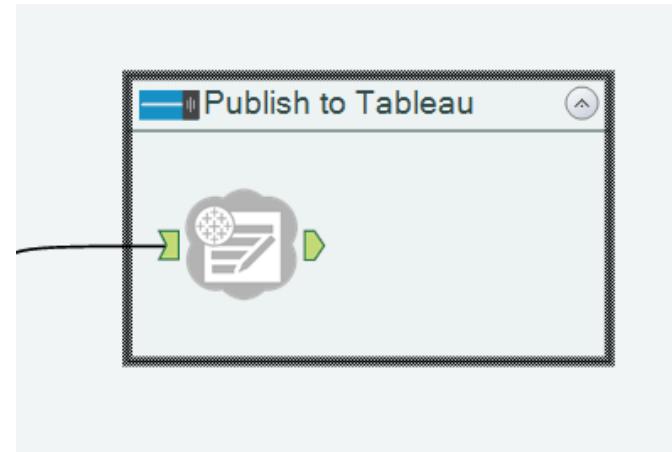
- *How long does the model take to run?*
- *How often does the model run?*
- *What kind of system does the model run on? What's its availability?*
- *What happens if your forecasts are not provided?*
 - *Is there an SLA to get them back up?*

Posting Data with Alteryx

alteryx

Publish To Tableau Tool

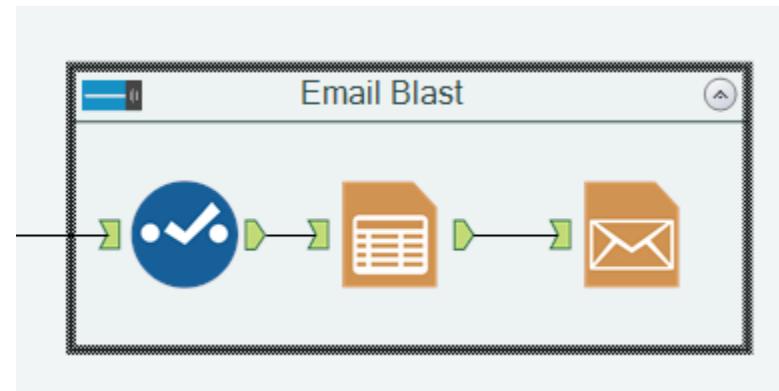
Easy and straight-forward way to create Tableau Data Sources on your company's Tableau Server



Reporting & Email Tools

Sends out an email summary of the forecasts and runtime data

Allows me to easily track the forecast uptime daily



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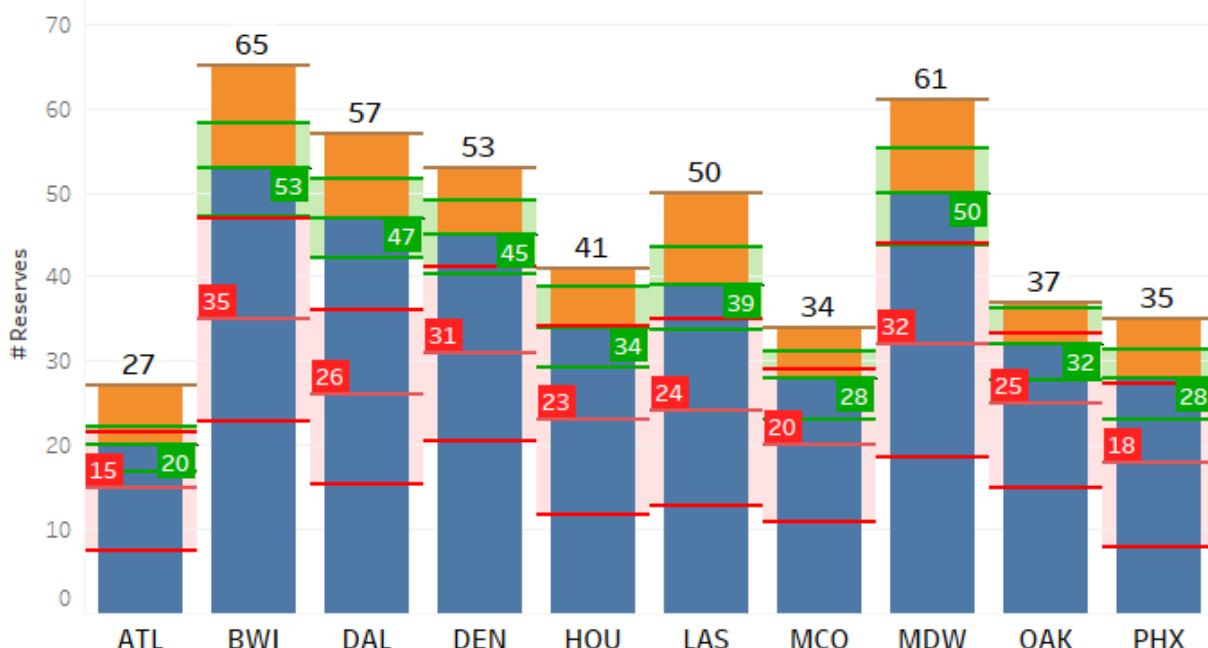
Visualization

Providing Forecasts to the
People/System That Uses Them

Inflight OT Tool Dashboard



3-Day Reserves Forecast
with Starting 3-Day Reserves and OT Forecast by Base



Forecast Color-code:

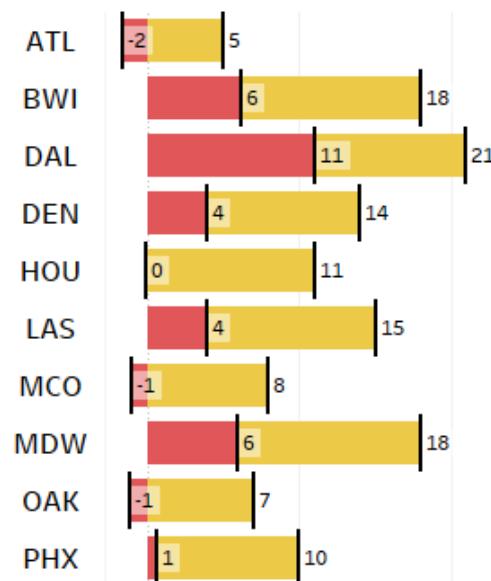
3-Day Reserve Forecast

New Sick Trip = Open Time Forecast

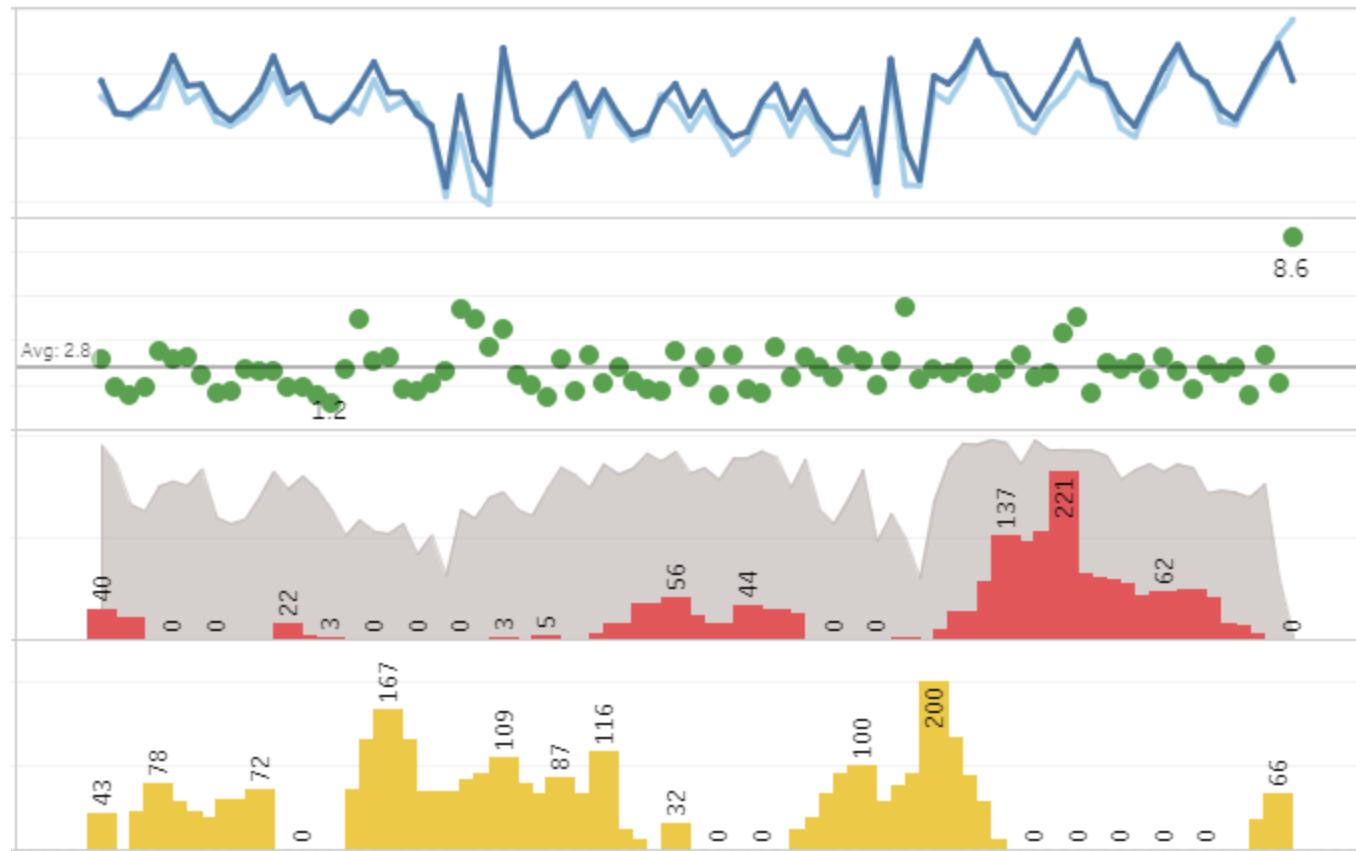
Inflight Open Time Decision Tool

09/22/2018

3-Day Reserves Forecast & OT Forecast Differences



IF Dashboard Monitoring



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Documentation

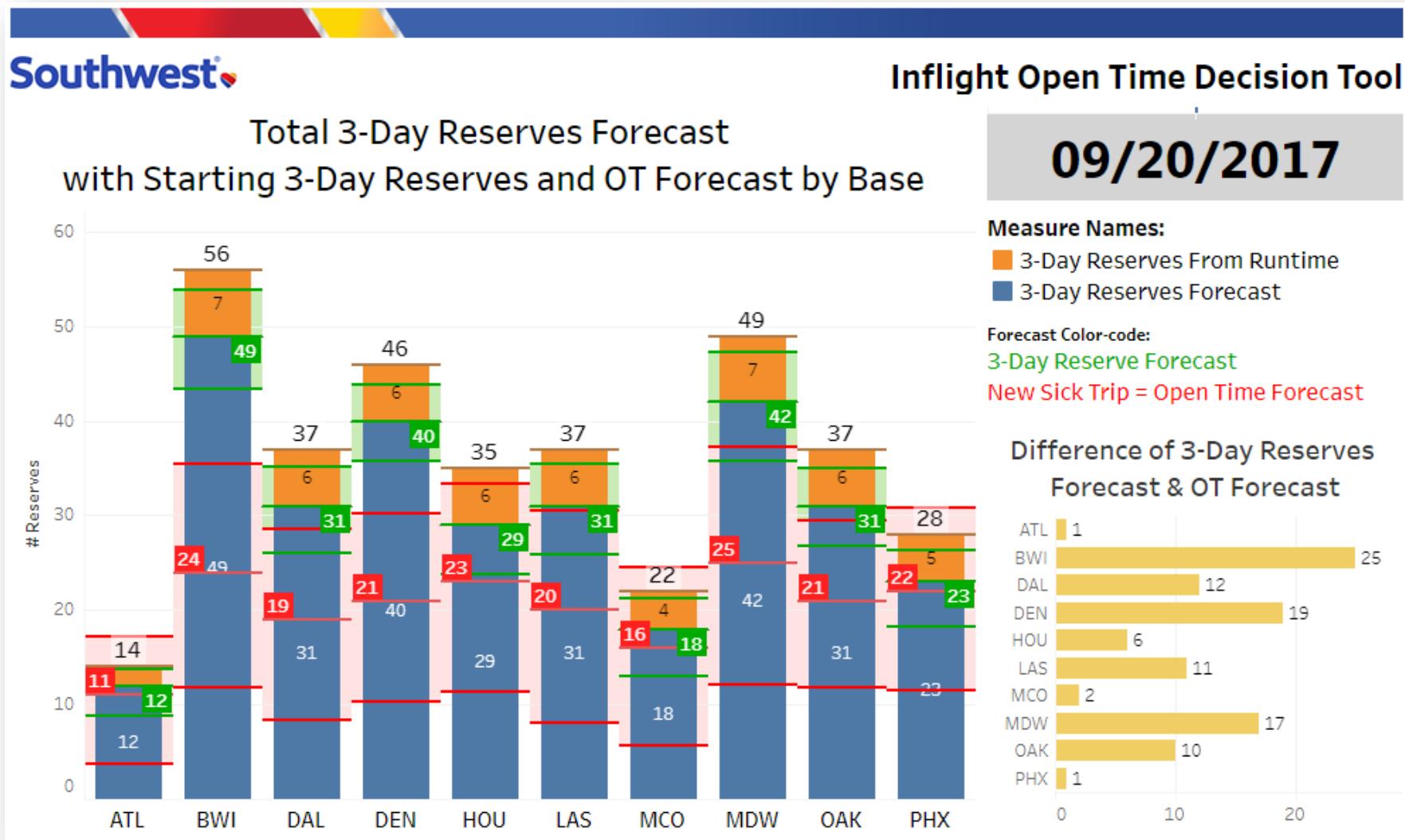
Documentation

- Considerations when writing code
- Documenting Weekly
- Passing work to other employees or Monitoring Groups

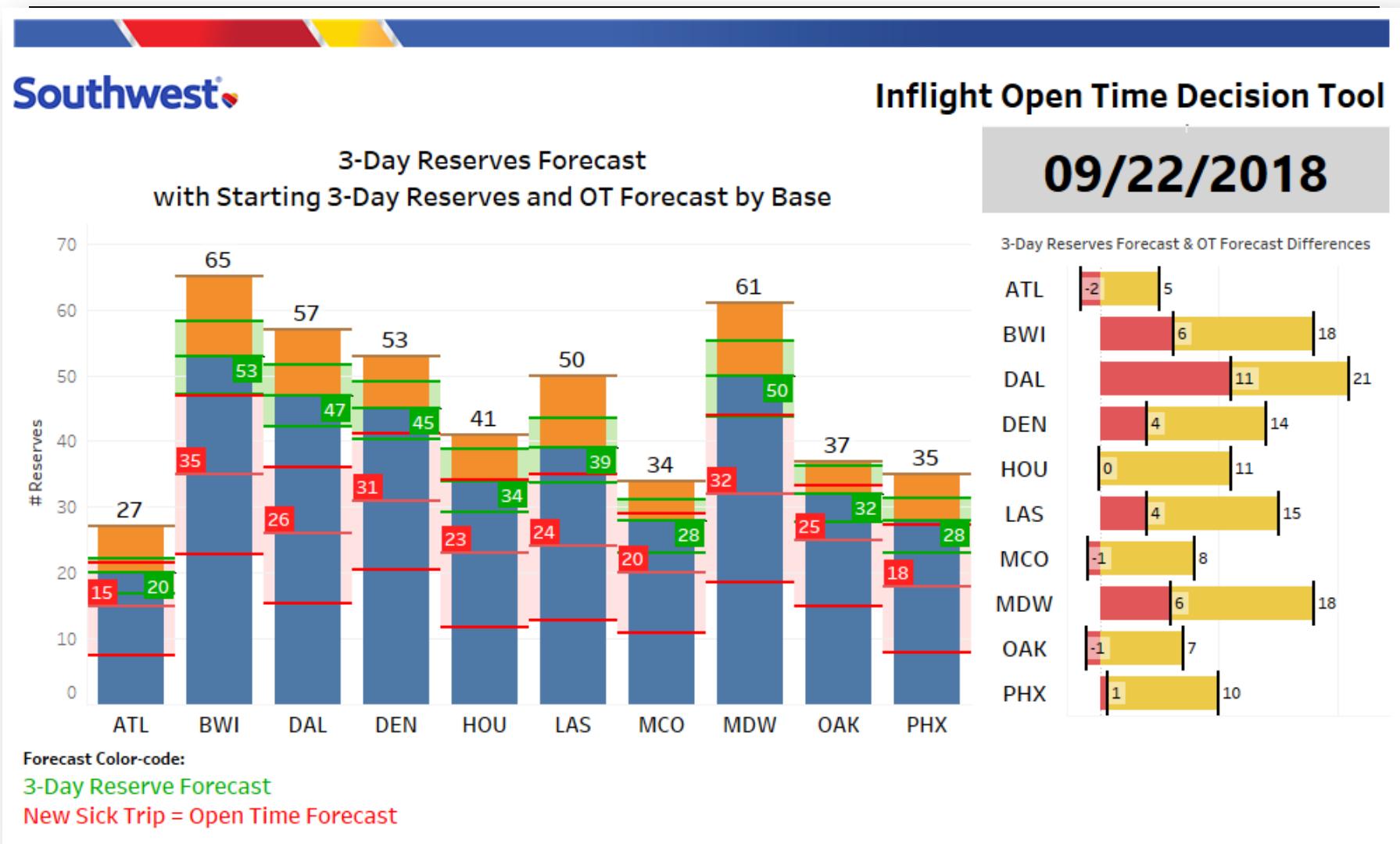
Support & Updates

- Customer requests for changes
- Fixing a broken model

Before



After



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Supplemental Resources

- Alteryx Use Case

The screenshot shows the Alteryx Community website interface. On the left, a vertical sidebar menu lists various categories: Getting Started (highlighted in green), Designer, Server, Connect, Promote, Academy, Blogs, Alter.Nation, Culture & Events, and Support. The main content area has a blue header bar with the Alteryx logo, a search bar, a knowledge base dropdown, a sign-in button, and an English (US) language selector. Below the header, a banner titled "ALTERYX USE CASES" features a photo of people working together. A modal window displays an announcement: "Announcement | Get certified today - take the Alteryx Designer Core and Advanced exams on-demand now!". The main article page for "Crew Reserve and Open Time Forecasting" is shown, with the URL being [Community > Getting Started > Alteryx Use Cases > Crew Reserve and Open Time Forecasting](#). The article is authored by alecsiemss (Atom) and was posted 3 weeks ago. It includes a Southwest Airlines logo. The right side of the page contains sections for "CONTRIBUTORS" (listing alecsiemss, DanielleR, Community_Admin, and okeefeb) and "RECOMMENDATIONS" (listing "Performing Time Series Forecasting in Alteryx Dest..." and "Time Series Forecasting").

Supplemental Resources

- Alteryx Webinar

The landing page features the Alteryx logo with the tagline "The Thrill of Solving". It includes a "FREE TRIAL" button and a "CONTACT US" button. The main title is "DATA DISRUPTORS" in large red letters, followed by the subtitle "Southwest Airlines Takes Off With Advanced Analytics". The background is a dark blue with a subtle wavy pattern.

WATCH THIS WEBINAR ON DEMAND

No matter what industry you're in, the pressure to provide faster insights for your business programs rests squarely on your team's shoulders. In the Data Disruptors webinar series, we're going to introduce you to people—from all types of businesses—who disrupted the status quo.

Our first disruptor comes from Southwest Airlines.

One of the biggest areas for disruption in the airline industry—a highly competitive space—centers around flight schedules and on the ground crew. Managing crew costs is a major challenge for airlines and is only expected to grow.

Watch our webinar with Alec Siems, Analyst at Southwest, and learn how the

WATCH NOW

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* Last Name
* Company Name
* Business Email Address
* Business Phone Number
* State, Country or Postal Code

Request Demo □

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