

Name	Count	% Total Count	% Bags	% br Food	% Food	% br Shop	% Shop	Weighted
all	11759	100	53	72	50	48	17	false
all.business	3643	31	42	73	52	48	17	false
all.business.domestic	3065	26	39	73	52	49	18	false
Name	2719	23	41	73	51	49	18	false
Name	347	3	73	71	49	42	9	false
all.business.international	577	5	58	73	52	42	10	false
Name	410	3	73	71	49	42	9	false
Name	167	1	23	79	60	43	11	false
all.business.departing	3129	27	45	72	51	48	17	false
all.business.transfer	514	4	24	78	55	48	17	false
all.leisure	4849	40	62	72	51	48	17	false
all.leisure.domestic	3348	28	59	72	50	48	20	false
Name	1301	11	70	73	52	42	10	false
Name	964	8	87	72	51	42	10	false
Name	337	3	22	77	55	42	9	false
all.leisure.international	3730	32	71	71	49	45	15	false
all.leisure.transfer	919	8	25	77	55	45	13	false
all.other	3467	29	54	69	48	48	17	false
all.other.domestic	2672	23	50	69	48	48	20	false
Name	2198	19	55	69	45	45	19	false
Name	474	4	25	72	51	52	23	false
all.other.international	795	7	67	69	47	42	9	false
Name	2729	23	61	68	45	45	17	false
Name	738	6	27	73	51	48	18	false
all.other.departing	9588	82	60	71	49	48	17	false
all.other.transfer	2171	18	25	76	55	47	15	false
all.domestic	9366	77	50	50	49	49	19	false
all.international	2873	23	67	72	51	42	10	false
all.departing	9588	82	60	71	49	48	17	false
all.transfer	2171	18	25	76	55	47	15	false

HIDE RESULTS  Save  profiles.csv  profiles.json

SHOW RESULTS  Show Results

>> PASSENGER TIMING SIMULATION

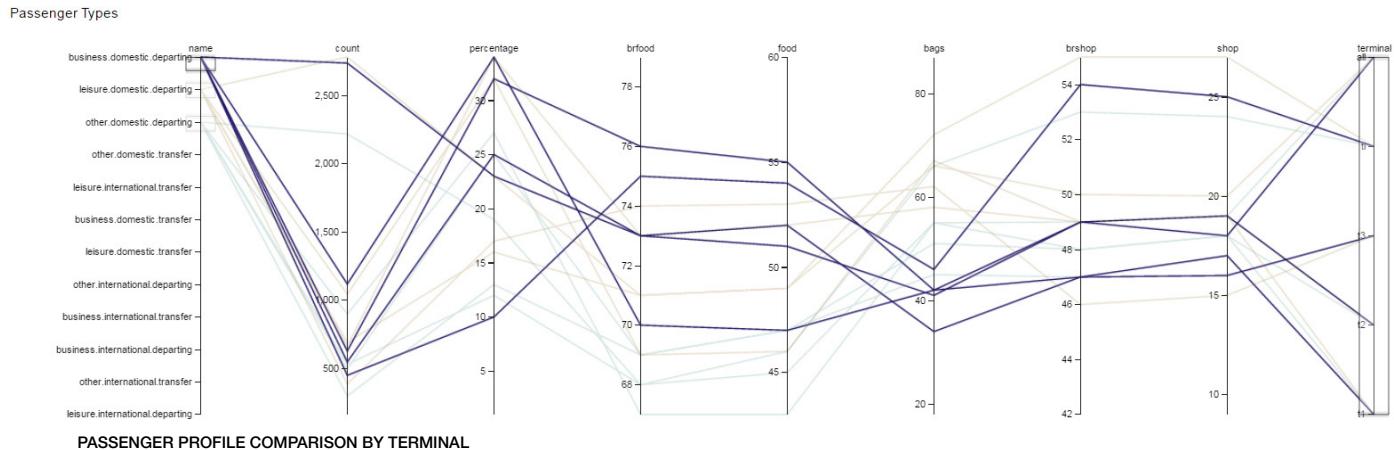
0.9 Load Factor  
0 to 24 Time Frame  
American Airlines Filter Flights  
leisure.departing Filter Passengers  
Run  
Show Results

# PASSENGER TYPE DISTRIBUTION AND PROFILE GENERATION

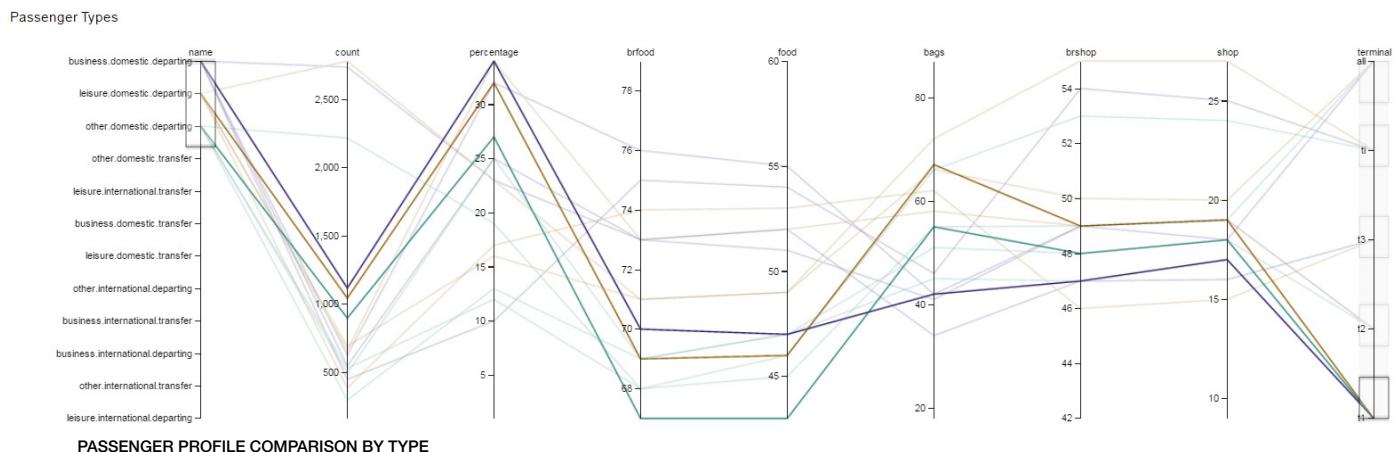
## BEHAVIORS IN RESPONSE TO SPATIAL CONDITIONS

In order to accurately simulate the behavioral patterns of passengers in the airport, preliminary work was done to distill passenger data into distinct types. An analysis of ~15000 responses to passenger satisfaction surveys conducted by SFO over the last 4 years (weighted by SFO to reflect actual customer traffic disbursement), in addition to prior research done by the ARCP, led to a combination of attributes permutable into 12 distinct types which were used to build a holistic picture of passenger behavioral patterns in the airport:

BUSINESS | LEISURE | OTHER / DOMESTIC | INTERNATIONAL / DEPARTING | TRANSFER



Output data from the analysis is an interactive graphic allowing for relative comparisons between occupancy patterns filtered by type, by terminal, or by propensity. The image above is a snapshot showing the purchasing propensities and total percentages of business.domestic.departing passengers (purple) for all 4 terminals of the San Francisco Airport, as well as the average propensity across all terminals. In addition, the cyan and orange represent equivalent propensities for leisure.domestic.departing and other.domestic.departing respectively for comparison.



The image above shows the relative comparisons of all three types of domestic passenger, filtered to display for terminal 1 only.

Passenger propensities towards un-measured variables were complemented by existing data sets for similar airports. In this case, the propensity of a passenger to browse a shop was not accounted for in the survey data. However, the Denver International Airport reported a set of data that showed a clear correlation between passenger browsing propensities and passenger buying propensities. Statistical linear regression was used to apply this correlation to the buying propensity of SFO passengers.

In addition, some assumptions were needed regarding the frequency of passenger bathroom breaks, walking speeds and the propensity to revisit certain concessions. This information could easily be inbedded within the simulation if it were available.

PASSENGER PROFILE TREE AND UNIQUE PASSENGER TYPES (WITH PROPENSITIES)

All	Terminal
<input type="checkbox"/> Run	Show Results
<input type="checkbox"/> Show Results	Hide Results
<input type="checkbox"/> Hide Results	Save
<input checked="" type="checkbox"/> aircraft.json	

## AIRCRAFT TYPE AND FLIGHT PROFILE GENERATION

### PASSENGER DISTRIBUTIONS AND ARRIVAL TIMES BY AIRCRAFT CATEGORY

In order to accurately simulate the behavioral patterns of passengers in the airport, preliminary work was done to distill passenger data into distinct

#### TOTAL PASSENGER PROFILES

#### UNIQUE PASSENGER PROFILES

#### AIRCRAFT PROFILES

^ C

Name	Count	% Passengers	Weighted	Arrival Distribution
C domestic	2363			--
C business.domestic.departing	789	33	0.000	--
C business.domestic.transfer	21	1	0.000	--
C leisure.domestic.departing	673	29	0.000	--
C leisure.domestic.transfer	147	6	0.000	--
C other.domestic.departing	548	23	0.000	--
C other.domestic.transfer	113	5	0.000	--

^ D

Name	Count	% Passengers	Weighted	Arrival Distribution
C business.international.departing	15	10	0.000	--
C business.international.transfer	74	50	0.000	--
C leisure.international.departing	19	13	0.000	--
C other.international.departing	31	21	0.000	--
C other.international.transfer	10	7	0.000	--

^ E

Name	Count	% Passengers	Weighted	Arrival Distribution
E domestic	444			--
E business.domestic.departing	75	17	0.000	--
E business.domestic.transfer	21	5	0.000	--
E leisure.domestic.departing	160	36	0.000	--
E leisure.domestic.transfer	53	12	0.000	--
E other.domestic.departing	101	23	0.000	--
E other.domestic.transfer	34	8	0.000	--
E international	656			--
E business.international.departing	99	15	0.000	--
E business.international.transfer	31	5	0.000	--
E leisure.international.departing	278	42	0.000	--
E leisure.international.transfer	70	11	0.000	--
E other.international.departing	121	18	0.000	--
E other.international.transfer	57	9	0.000	--

^ F

Name	Count	% Passengers	Weighted	Arrival Distribution
F domestic	43			--
F leisure.domestic.departing	30	70	0.000	--
F leisure.domestic.transfer	1	2	0.000	--
F other.domestic.departing	10	23	0.000	--
F other.domestic.transfer	2	5	0.000	--
F international	144			--
F business.international.departing	23	16	0.000	--
F business.international.transfer	7	5	0.000	--
F leisure.international.departing	58	40	0.000	--
F leisure.international.transfer	9	6	0.000	--
F other.international.departing	35	24	0.000	--
F other.international.transfer	12	8	0.000	--

>> PASSENGER TIMING SIMULATION

0.9	Load Factor
0 to 24	Time Frame
American Airlines	Filter Flights
leisure.departing	Filter Passengers
<input type="checkbox"/> Run	Show Results
<input type="checkbox"/> Show Results	Show Results

FLIGHTS

PASSENGERS

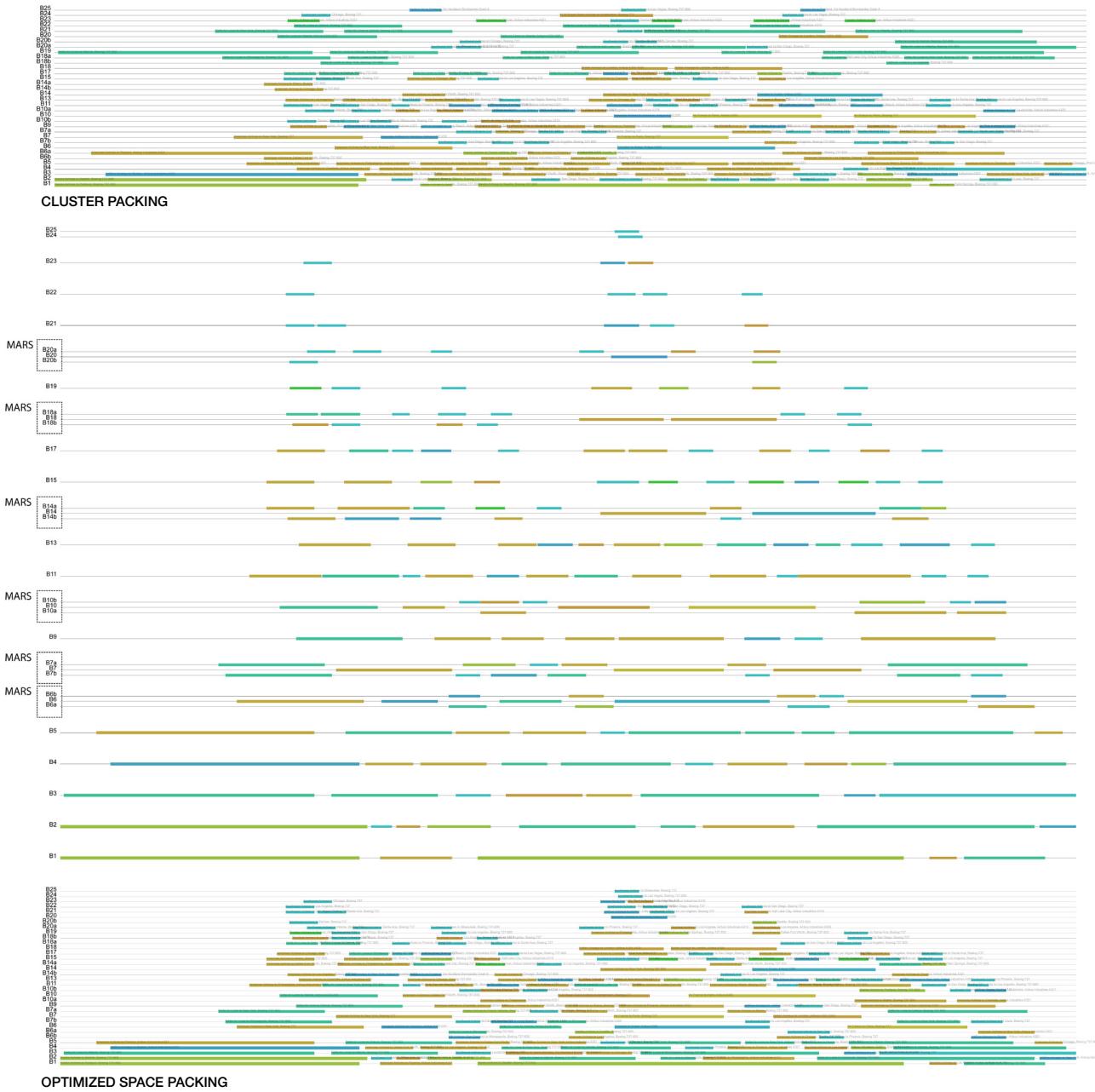
AIRCRAFT PROFILE TREE AND PASSENGER TYPE DISTRIBUTIONS

All	Terminal
Run	Show Results
Show Results	Show Results
Show Results	Show Results
Show Results	Show Results

# FLIGHT GATE ALLOCATION

## GATE PACKING OPTIMIZATION AND SPATIAL CONFIGURATION

For the output from the passenger timing simulation to be linked to an existing design scheme, part of the necessary input is the peak design day flight schedule. In this case, the schedule included all desired flights out of SFO on a maximum capacity day in 2023. This data was then filtered by terminal to include flights strictly for Terminal 1.



Given that flights from the design day have not been assigned a gate, and in order to tie the simulation to the CAD plan of a test fit during the design phase, two kinds of gate packing are implemented in order to simulate passenger flow through the concourse. Both are capable of handling Multi Aircraft Ramping System (MARS) gates, and are aware of gate size and design group restrictions during flight allocation. A database of turnaround times by aircraft, and by airline were used along with aviation industry standards for time padding on interval extents in order to allocate the necessary amount of time for each flight.

Optimized space packing assigns flights to gates as closely as possible, potentially eliminating unnecessary gates. Airlines are distributed without location preferences on the concourse and there is no attempt to keep flights from a single airline together.

Cluster packing is slightly less optimal, but maintains groups of airlines together as well as specific gate allocations to airlines.

### TOTAL PASSENGER PROFILES

### UNIQUE PASSENGER PROFILES

### AIRCRAFT PROFILES

### FLIGHTS

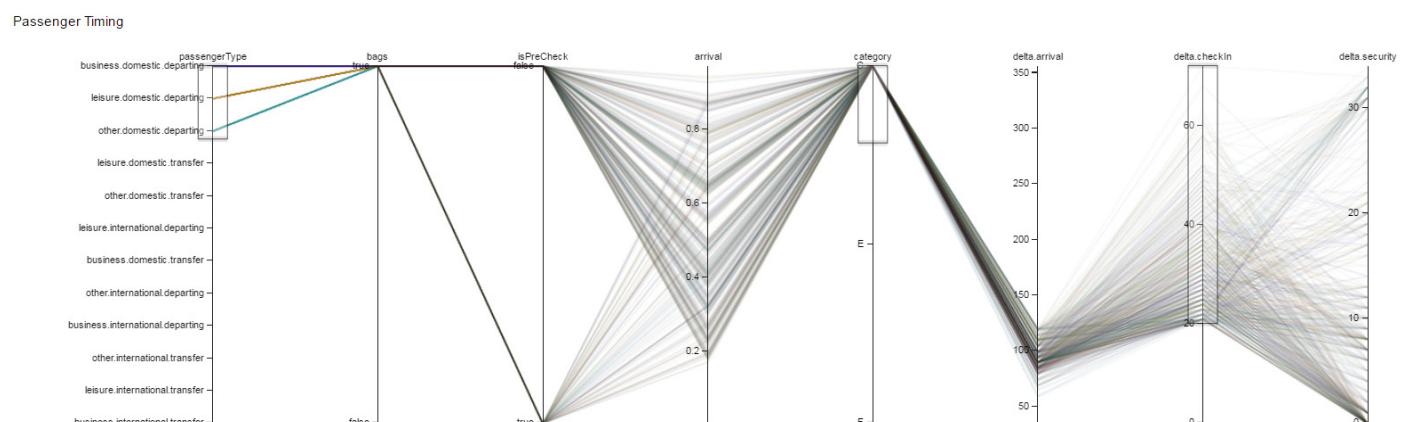
Name	Code	Flight ID	Load Factor	Seats	Passenger Count	Gate	Departure Time
American Airlines to Phoenix, Airbus Industries A321	AA	f1f4993-4005-4966-9ae1-1a2228948433	1	183	155	B6a	06:00:00
American Airlines to Charlotte, Airbus Industries A321	AA	8090023c-3aa7-4b05-a9d0-63379047a4d0	1	183	155	B3	10:59:59
American Airlines to Philadelphia, Airbus Industries A321	AA	10202057-f15-4223-a284-35900793610	1	183	155	B6b	10:59:59
American Airlines to Charlotte, Airbus Industries A321	AA	10202057-f15-4223-a284-35900793610	1	183	155	B1	11:13:00
American Airlines to Phoenix, Airbus Industries A321	AA	8951e399-4005-4966-9ae1-1a2228948433	1	183	155	B6b	11:13:00
American Airlines to Charlotte, Airbus Industries A321	AA	6011c37-4923-453a-89d5-7e63359a23a	1	183	170	B15	11:20:00
American Airlines to Philadelphia, Airbus Industries A321	AA	123239a-7655-4890-9100-35900793610	1	183	165	B5	11:30:00
American Airlines to Phoenix, Airbus Industries A321	AA	d0c7774d-55ca-4894-90a4-e104ee455d3	1	183	160	B5	11:40:00
American Airlines to Philadelphia, Airbus Industries A321	AA	695f0056-4747-4297-914-16e305c03099	1	183	173	B4	11:49:59
American Airlines to Phoenix, Airbus Industries A321	AA	a1693040-305c-4945-9855-52d998cc0fa	1	183	178	B5	11:50:00
American Airlines to Philadelphia, Airbus Industries A321	AA	0f1a29a8-4735-4806-8510-9af2e20a0ad1	1	183	175	B6a	12:00:00
American Airlines to Phoenix, Airbus Industries A321	AA	35e80020-365a-4945-9855-52d998cc0fa	1	183	179	B7a	12:03:00
American Airlines to New York, Airbus Industries A321	AA	00a0722c-8a17-4244-9a73-5a971789407	1	183	155	B5	12:05:00
American Airlines to Phoenix, Airbus Industries A321	AA	c020b179-0745-4244-341f-16294691ee	1	183	163	B4	09:15:00
American Airlines to Philadelphia, Airbus Industries A321	AA	d1a391a4-6353-4f1c-a050-61213829906	1	183	162	B5	09:20:59
American Airlines to Philadelphia, Airbus Industries A321	AA	e7a197e-420b-456b-87b1-7507976af3	1	183	179	B5	08:18:00
American Airlines to Charlotte, Airbus Industries A321	AA	f2c230d-4165-4334-a7b5-700aae0504	1	183	164	B4	07:20:00
American Airlines to Los Angeles, Boeing 737-800	AA	3d02aef-41f1-473c-9a81-e433a767090	1	149	151	B5	10:04:00
American Airlines to Dallas-Fort Worth, Boeing 737-800	AA	0e60a37-4209-40e6-905f-95671233	1	149	146	B7a	10:35:59
American Airlines to Chicago, Boeing 737-800	AA	701195a-4209-40e6-905f-95671233	1	149	146	B7a	10:36:00
American Airlines to Chicago, Boeing 737-800	AA	0e60a37-4209-40e6-905f-95671233	1	149	146	B7a	10:36:00
American Airlines to New York, Boeing 737-800	AA	5a166629-3152-4552-9a73-61793a298	1	149	144	B5	12:54:59
American Airlines to Miami, Boeing 737-800	AA	3d6fb23e-12d4-438c-a309-264a143479	1	149	144	B3	13:02:00
American Airlines to Los Angeles, Boeing 737-800	AA	ac1f1a3-8950-4071-8529-26615059d7	1	149	135	B6b	12:49:59
American Airlines to Chicago, Boeing 737-800	AA	d1333347-37d3-4504-bee9-1045716075	1	149	141	B13	13:30:00
American Airlines to Chicago, Boeing 737-800	AA	5eaa50-4324-a9a9-0013-9ef10341518	1	149	141	B4	14:10:00
American Airlines to Los Angeles, Boeing 737-800	AA	655250d0-4071-4071-0258-0556247103	1	149	142	B15	14:19:59
American Airlines to Dallas-Fort Worth, Boeing 737-800	AA	51d4a387-4153-4806-9884-237175371	1	149	142	B5	15:19:59
American Airlines to Dallas-Fort Worth, Boeing 737-800	AA	33d03673-3823-4252-2652056547	1	149	138	B5	16:32:00
American Airlines to Dallas-Fort Worth, Boeing 737-800	AA	c70e023-0773-4105-bc23-7200020551	1	149	133	B7a	16:35:59
American Airlines to Dallas-Fort Worth, Boeing 737-800	AA	1643994-3a5b-4797-8160-406763d3026	1	149	136	B13	16:59:59
American Airlines to Los Angeles, Boeing 737-800	AA	40b1618-0431-4450-8657-75519301215	1	149	140	B7b	17:18:00
American Airlines to Chicago, Boeing 737-800	AA	1ea75807-0005-4879-8438-6560540f6	1	149	147	B6a	17:50:00
American Airlines to Miami, Boeing 737-800	AA	60ba082-5504-4025-ba50-296036716126	1	149	147	B6b	20:05:00
American Airlines to Chicago, Boeing 737-800	AA	46594340-3005-4538-9149-3438757031	1	149	142	B5	20:35:00
American Airlines to Dallas-Fort Worth, Boeing 737-800	AA	101002-3171-4054-9149-1645104749	1	149	142	B13	08:19:59
American Airlines to Chicago, Boeing 737-800	AA	59a241f-4111-4485-9371-20562101	1	149	143	B14	06:12:00
American Airlines to Miami, Boeing 737-800	AA	ad73859-0047-4581-80e3-0497a2d50f	1	149	142	B15	09:20:00
American Airlines to Los Angeles, Boeing 737-800	AA	42c139f-1937-4865-8160-1360077215	1	149	135	B14	09:20:00
American Airlines to Dallas-Fort Worth, Boeing 737-800	AA	cd10297-37a1-4723-0a30-3a391405300	1	149	135	B13	09:25:59
American Airlines to Los Angeles, Boeing 737-800	AA	4096975-5572-4049-8246-65605056413	1	149	141	B6b	05:00:00
American Airlines to Dallas-Fort Worth, Boeing 737-800	AA	7ea1062-3340-4356-0169-0400303031	1	149	142	B13	07:50:00
American Airlines to Dallas-Fort Worth, Boeing 737-800	AA	8a1f029a-05a9-4320-0250-11645104749	1	149	142	B13	08:19:59
American Airlines to Chicago, Boeing 737-800	AA	4549543-4545-4538-9149-3438757031	1	149	142	B13	08:20:00
American Airlines to Dallas-Fort Worth, Boeing 737-800	AA	1a0c9991-0a20-4254-9585-9195a054	1	247	252	B7	07:09:59
American Airlines to New York, Boeing 777	AA	a345495-07f1-407c-947c-0a49751010	1	304	320	B6	09:12:00
American Airlines to Dallas-Fort Worth, Boeing 787-800	AA	97563e57-2365-4499-929a-31a0312675	1	219	229	B14	09:14:59
American Airlines to New York, Boeing 787-800	AA	45b0039-0526-40a8-8900-56359135982	1	216	210	B10	17:50:00
Air France to Paris, Airbus A380	AF	16739342-0a85-4300-8304-340ff40e11	1	310	297	B7	15:42:00
Air France to Paris, Boeing 777	AF	1740057-0271-4105-0e69-2363306948	1	310	298	B10	21:24:59
Air France to Paris, Boeing 777	AF	1813099-2270-4094-a769-0672765968	1	157	147	B5	10:09:59
Alaska Airlines to Seattle, Boeing 737-800	AS	0302229-4476-4499-929a-31a0312675	1	157	153	B2	11:53:59
Alaska Airlines to Seattle, Boeing 737-800	AS	0302229-4476-4499-929a-31a0312675	1	157	153	B2	11:54:59
Alaska Airlines to Los Angeles, Boeing 737-800	AS	0470956-4202-4243-9692-5320071493	1	172	165	B17	15:44:59
Alaska Airlines to Seattle, Boeing 737-800	AS	0470956-4202-4243-9692-5320071493	1	172	165	B17	15:45:59
Alaska Airlines to Seattle, Boeing 737-800	AS	0470956-4202-4243-9692-5320071493	1	172	165	B17	15:46:59
Alaska Airlines to Seattle, Boeing 737-800	AS	0470956-4202-4243-9692-5320071493	1	172	165	B17	15:47:59
Alaska Airlines to Seattle, Boeing 737-800	AS	0470956-4202-4243-9692-5320071493	1	172	165	B17	15:48:59
Alaska Airlines to Seattle, Boeing 737-800	AS	0470956-4202-4243-					

# PASSENGER TIMING SIMULATION

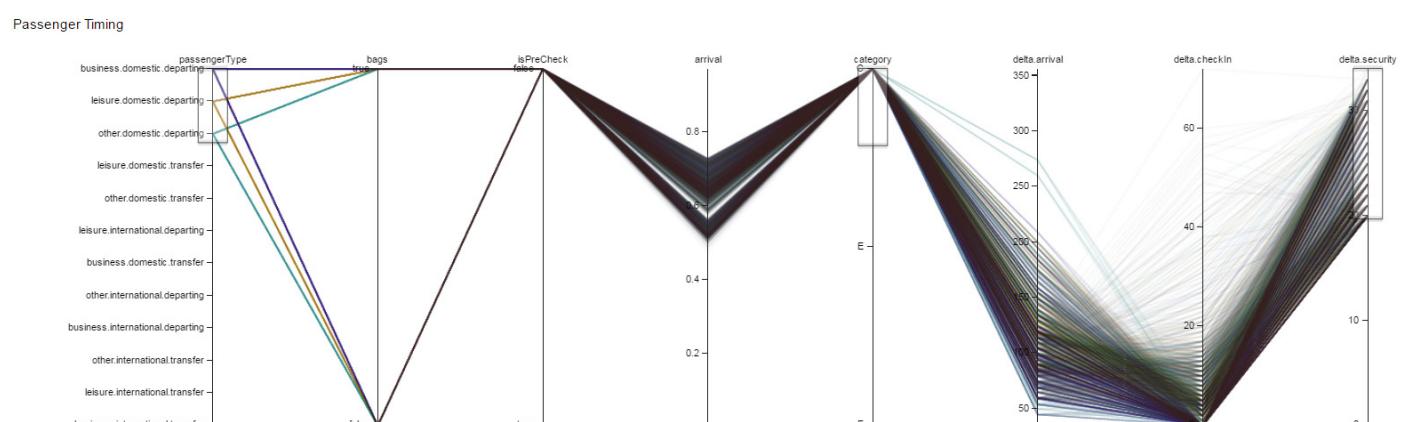
# CURBSIDE TO DEPARTURE PASSENGER TIMING GENERATION

Using the pre-computed passenger types and aircraft types unique to the airport, and coupled with the design day flight schedule and design scheme variables, the preliminary passenger timing simulation produces a set of passengers corresponding to the test load factor for every flight out of the airport over the course of the design day. These passengers are assigned event timing values corresponding with the moments that they reach certain events :

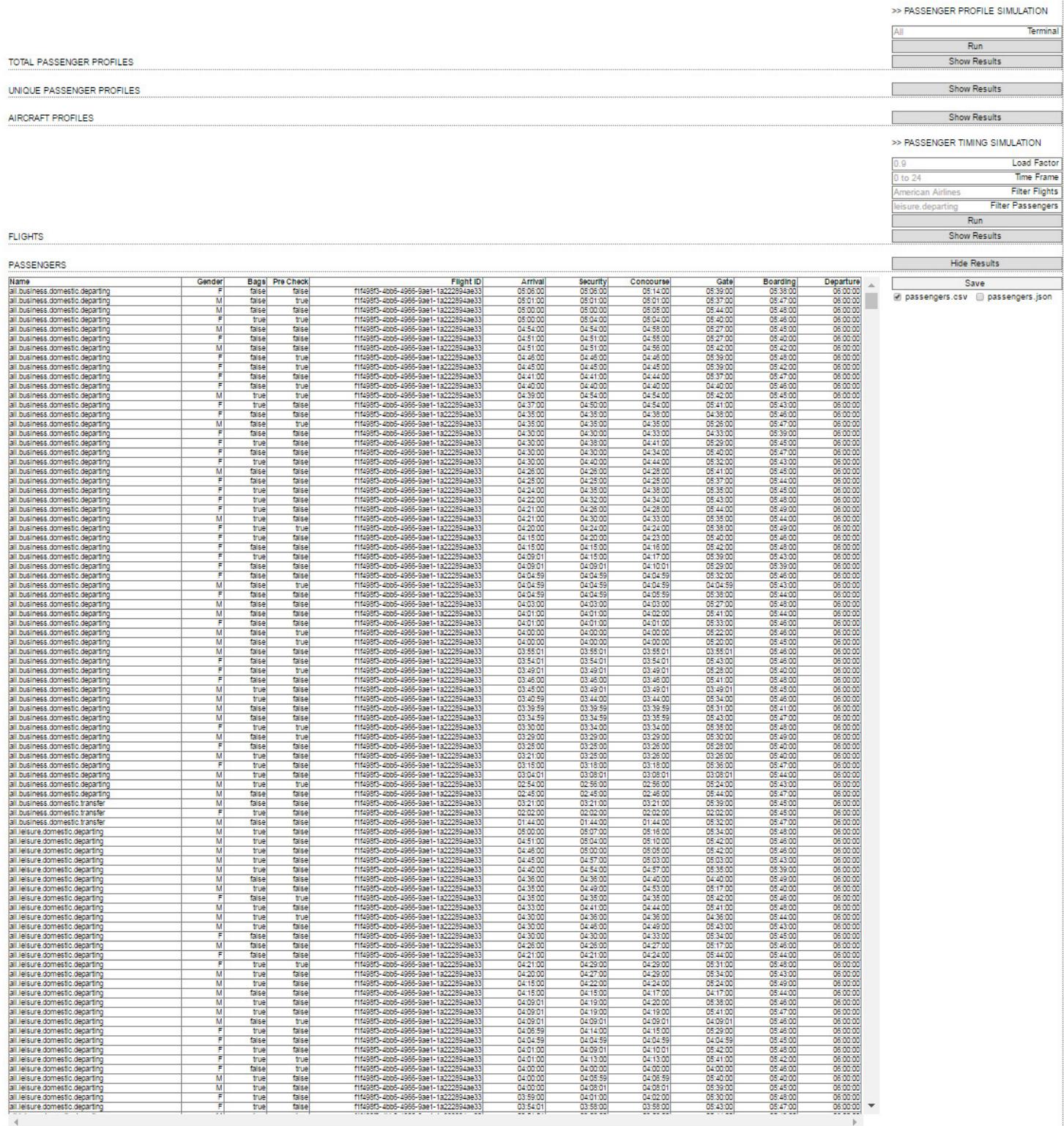
ARRIVAL | CHECK-IN | SECURITY | CONCOURSE | GATE | BOARDING | DEPARTURE



## TYPE C DOMESTIC PASSENGER TIMING FILTERED BY CHECK-IN TIME

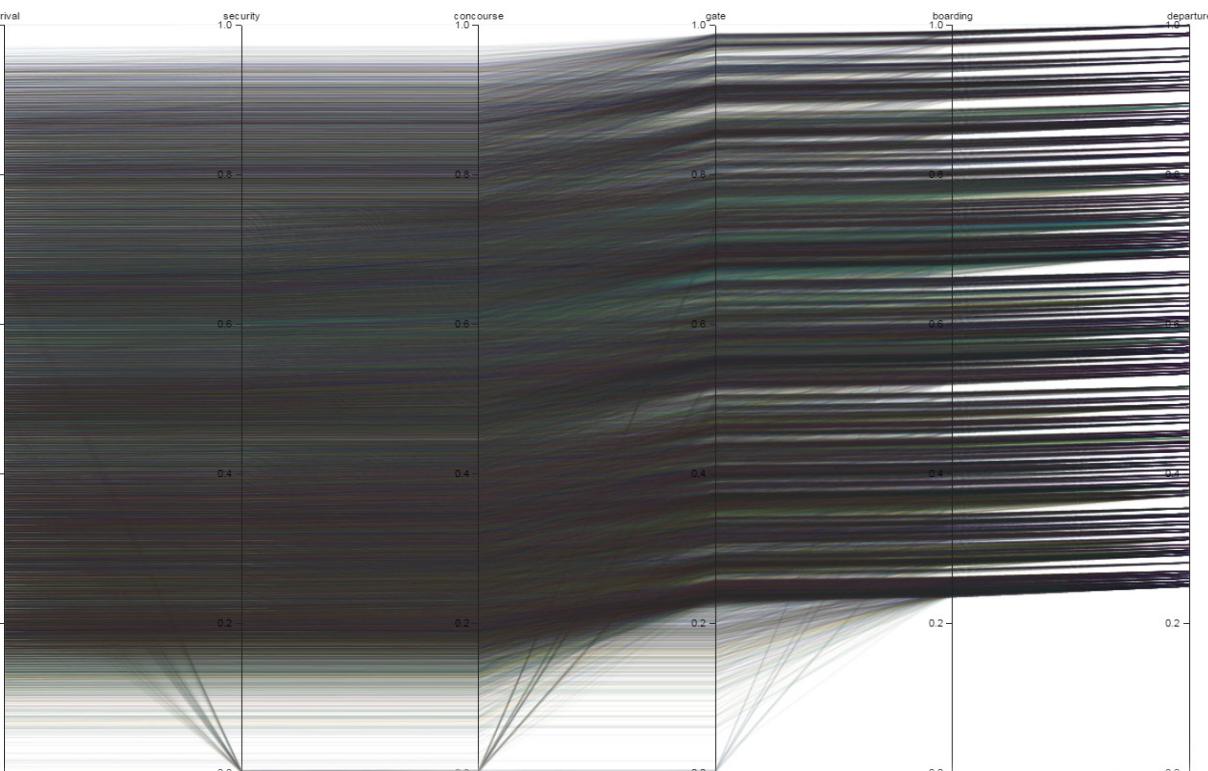
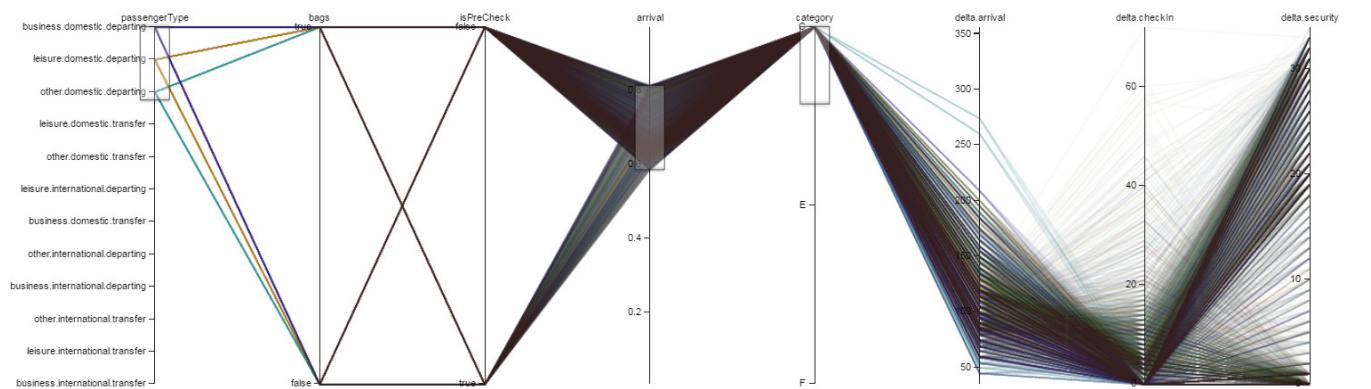


TYPE C DOMESTIC PASSENGER TIMING FILTERED BY SECURITY TIME



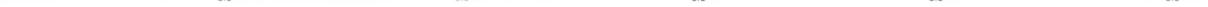
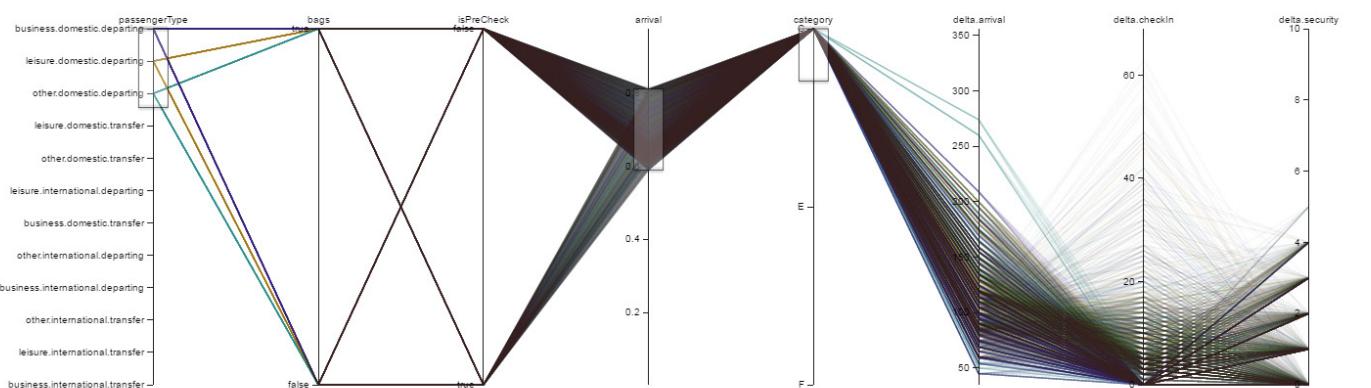
## SIMULATED PASSENGER OUTPUT WITH EVENT TIMINGS AND PROFILE ATTRIBUTES

Passenger Timing



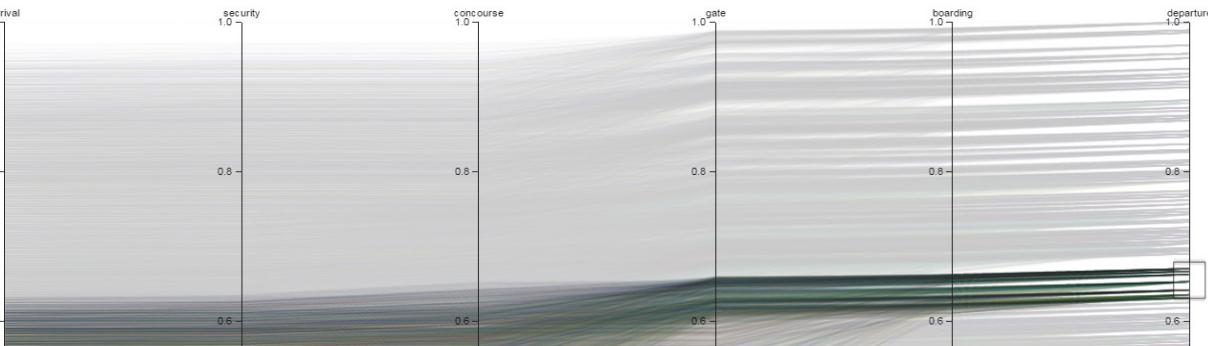
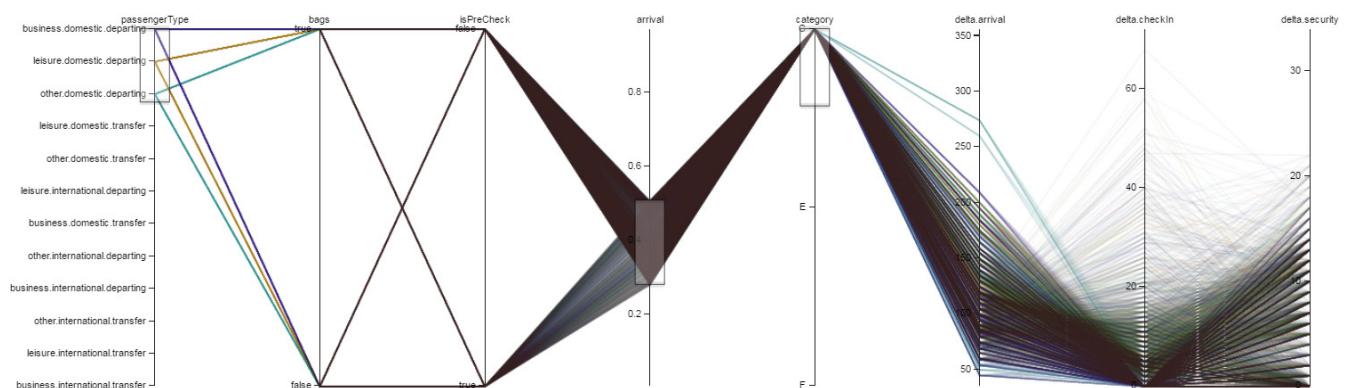
DOMESTIC PASSENGER SECURITY TIMES | AFTERNOON PEAK - SCHEME I (10/12 SECURITY LINES)

Passenger Timing



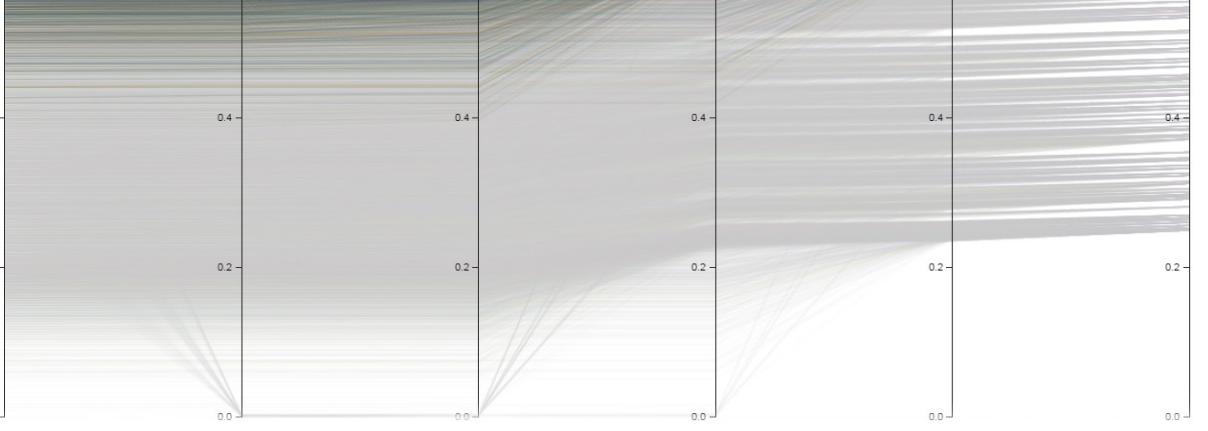
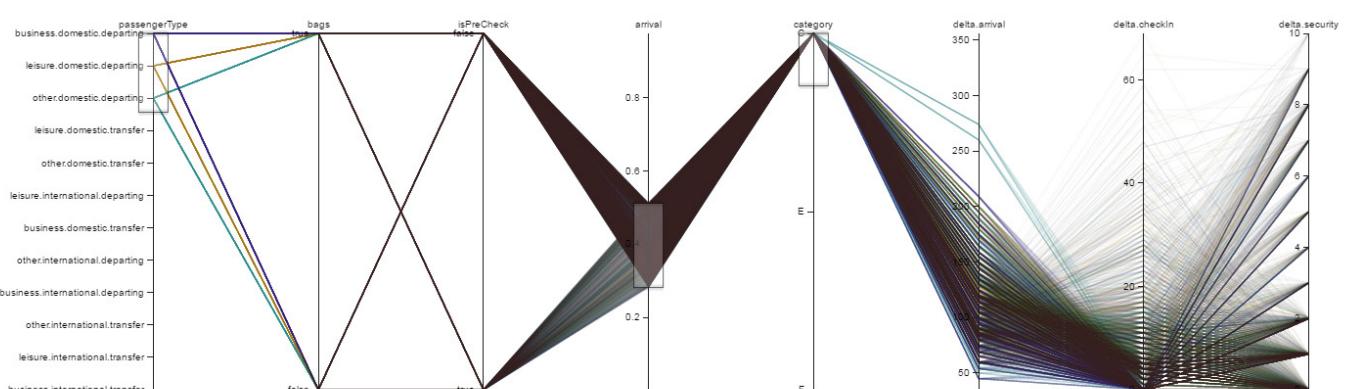
DOMESTIC PASSENGER SECURITY TIMES | AFTERNOON PEAK - SCHEME II (10/16 SECURITY LINES)

Passenger Timing



DOMESTIC PASSENGER SECURITY TIMES | MORNING PEAK - SCHEME I (10/12 SECURITY LINES)

Passenger Timing



DOMESTIC PASSENGER SECURITY TIMES | MORNING PEAK - SCHEME II (10/16 SECURITY LINES)





**SFO****Terminal 1 B/A B**

Passengers (PAX)

- all.business.domestic.departing
- all.business.domestic.transfer
- all.business.international.departing
- all.business.international.transfer
- all.leisure.domestic.departing
- all.leisure.domestic.transfer
- all.leisure.international.departing
- all.leisure.international.transfer
- all.other.domestic.departing
- all.other.domestic.transfer
- all.other.international.departing
- all.other.international.transfer

