SUPERSPACE

Aviation simulation

A system for air-side passenger behavior simulation

01

Data Analysis

PASSENGER
Type : leisure.domestic.departing Gender : F bags : false isPreCheck : true isTransfer : false Flight Name : AA to Los Angeles, Boeing 737-800 Timing Profile : brshop / shop : 52 /22 brfood / food : 73 / 51

Preliminary data collection and analysis of key metrics for building unique passenger and flight profiles.

Specifications for passenger types:

- Propensities towards air-side behavioral patterns (buying from duty-free, F+b, etc...)
- Propensities towards land-side behavioral patterns (bag-check, global entry, pre-check, etc...)
- Arrival patterns

Specifications for flight types:

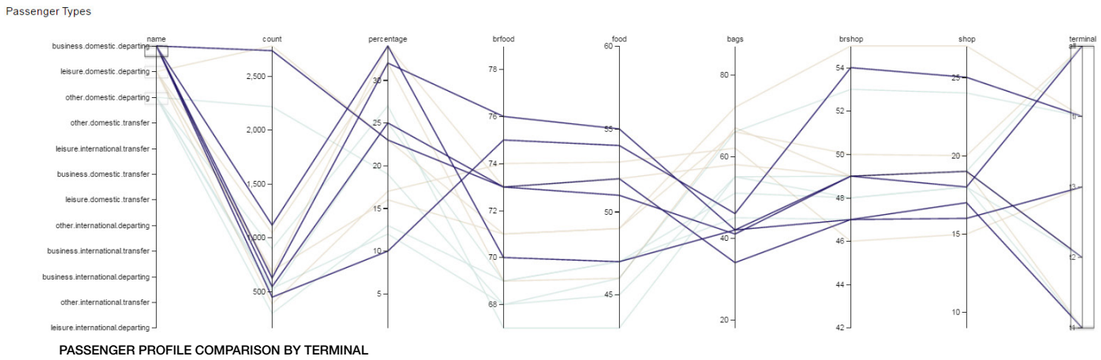
- Propensities towards passenger type distributions
- Current/expected turnaround times by airline/aircraft
- Design day flight schedule/gate scheme
- Load factor

DATA ANALYSIS

PASSENGER TYPE DISTRIBUTION AND PROFILE GENERATION

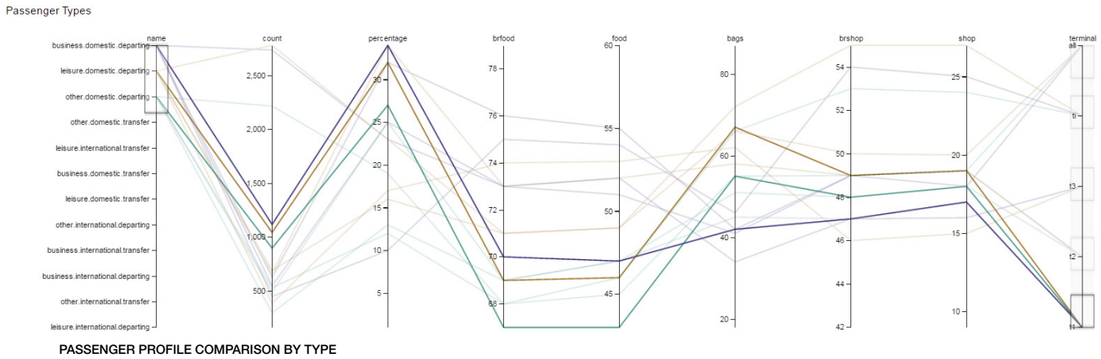
In order to accurately simulate the behavioral patterns of passengers in the airport, preliminary work was done to distill passenger data into distinct types. An analysis of ~15000 reponses to passenger satisfaction surveys conducted by SFO over the last 4 years (weighted by SFO to reflect actual customer 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



PASSENGER PROFILE COMPARISON BY TERMINAL

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 accross all terminals. In addition, the cyan and orange represent equivalent propensities for leisure.domestic.departing and other.domestic.departing respectively for comparison.

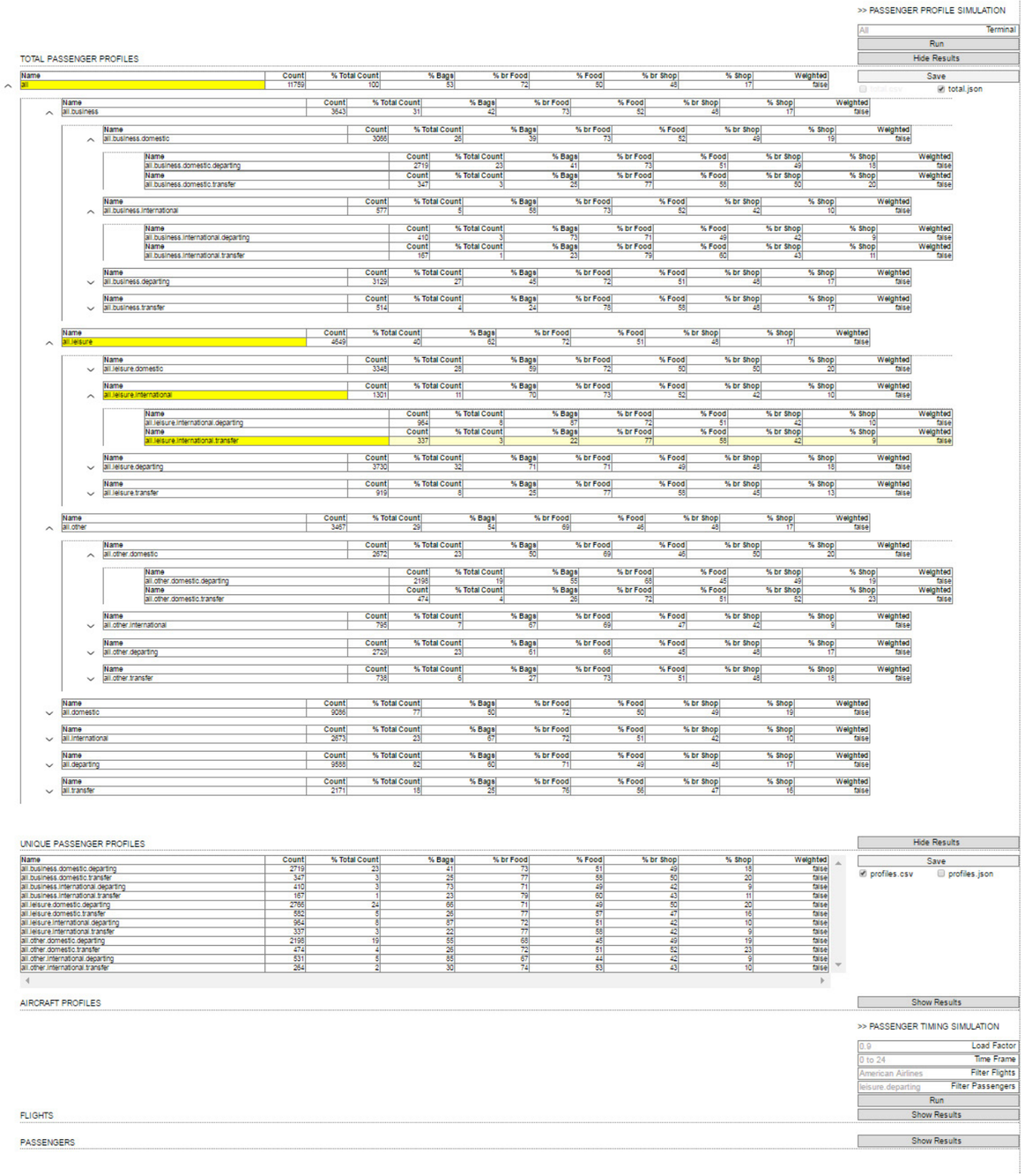


PASSENGER PROFILE COMPARISON BY TYPE

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 browsing 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)

DATA ANALYSIS

AIRCRAFT TYPE AND FLIGHT PROFILE GENERATION

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

>> PASSENGER PROFILE SIMULATION

All — Terminal

Run

TOTAL PASSENGER PROFILES — Show Results

UNIQUE PASSENGER PROFILES — Show Results

AIRCRAFT PROFILES — Hide Results

Save

aircraft.json

C

Name	Count
C.domestic	2363

Name	Count	% Passengers	Weighted	Arrival Distribution
C.business.domestic.departing	788	33	false	--
C.business.domestic.transfer	89	4	false	--
C.leisure.domestic.departing	675	29	false	--
C.leisure.domestic.transfer	147	6	false	--
C.other.domestic.departing	548	23	false	--
C.other.domestic.transfer	113	5	false	--

Name	Count
C.international	149

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

E

Name	Count
E.domestic	444

Name	Count	% Passengers	Weighted	Arrival Distribution
E.business.domestic.departing	75	17	false	--
E.business.domestic.transfer	21	5	false	--
E.leisure.domestic.departing	160	36	false	--
E.leisure.domestic.transfer	53	12	false	--
E.other.domestic.departing	101	23	false	--
E.other.domestic.transfer	34	8	false	--

Name	Count
E.international	666

Name	Count	% Passengers	Weighted	Arrival Distribution
E.business.international.departing	99	15	false	--
E.business.international.transfer	31	5	false	--
E.leisure.international.departing	278	42	false	--
E.leisure.international.transfer	70	11	false	--
E.other.international.departing	121	18	false	--
E.other.international.transfer	57	9	false	--

F

Name	Count
F.domestic	43

Name	Count	% Passengers	Weighted	Arrival Distribution
F.leisure.domestic.departing	30	70	false	--
F.leisure.domestic.transfer	1	2	false	--
F.other.domestic.departing	10	23	false	--
F.other.domestic.transfer	2	5	false	--

Name	Count
F.international	144

Name	Count	% Passengers	Weighted	Arrival Distribution
F.business.international.departing	23	16	false	--
F.business.international.transfer	7	5	false	--
F.leisure.international.departing	58	40	false	--
F.leisure.international.transfer	9	6	false	--
F.other.international.departing	35	24	false	--
F.other.international.transfer	12	8	false	--

>> PASSENGER TIMING SIMULATION

0.9 — Load Factor

0 to 24 — Time Frame

American Airlines — Filter Flights

leisure.departing — Filter Passengers

Run

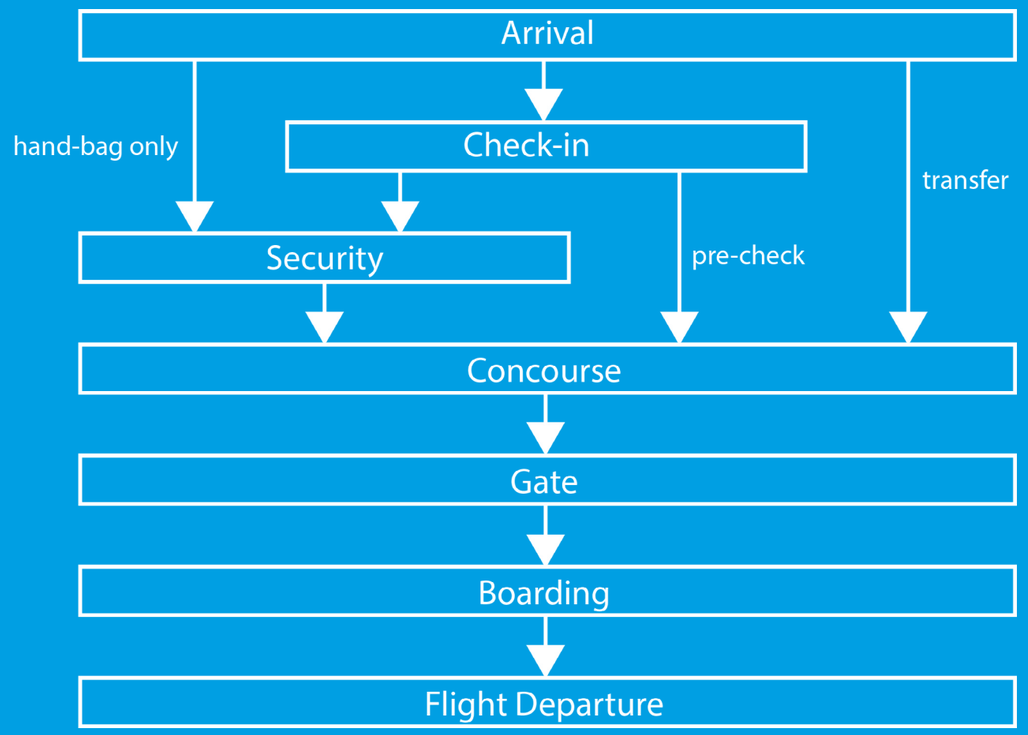
FLIGHTS — Show Results

PASSENGERS — Show Results

AIRCRAFT PROFILE TREE AND PASSENGER TYPE DISTRIBUTIONS

02

Passenger Timing Simulation



The passenger timing model generates timing profiles for all passengers from curbside to departure using passenger profiles, arrival rates and flight type distributions. These journeys are split into a series of timing events that feed into the passenger spatial simulation.

The system outputs a series of passengers with corresponding timings, as well as :

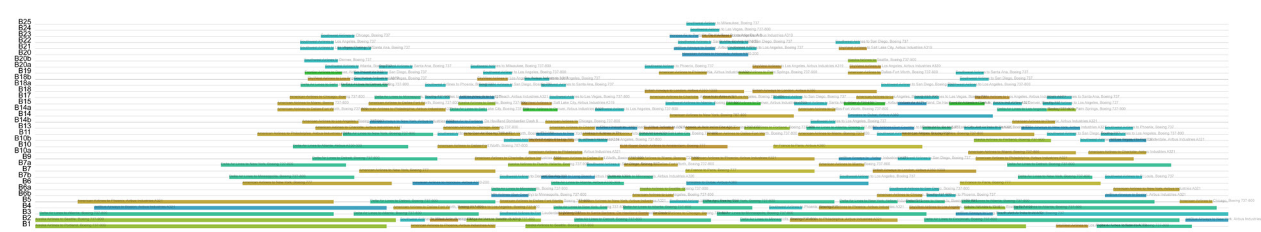
- Information about arrival rates and queuing times based on the current scheme and flight schedule
- Optimized gate allocation (if none present) based on the unique flight profiles, allowing the spatial simulation to be linked to a CAD design scheme for the simulation of concession usage for the given design day.

PASSENGER TIMING SIMULATION

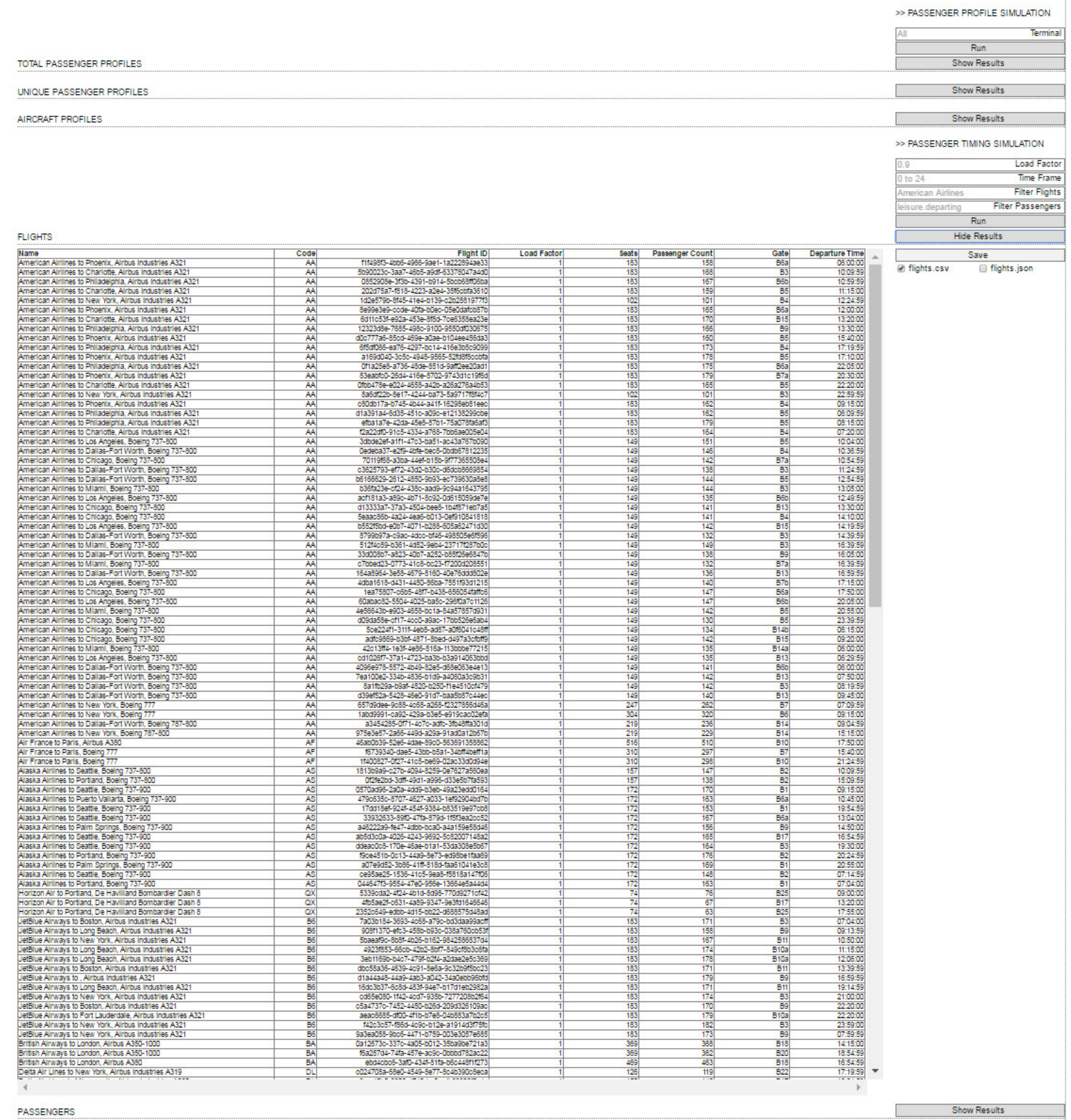
GATE PACKING OPTIMIZATION AND SPATIAL CONFIGURATION

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.

CLUSTER PACKING



OPTIMIZED SPACE PACKING



SIMULATED FLIGHT OUTPUT WITH GATE ALLOCATIONS AND PASSENGER COUNT

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 to simulate passenger flow through the concourse. Both can account for 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 allong with aviation industry standards for time padding on interval extents in order to allocate the nessessary 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.

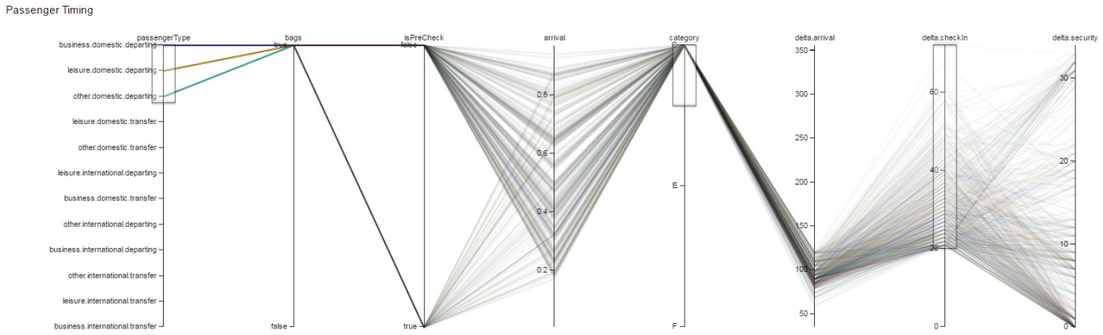
- Cluster packing is slightly less optimal, but maintains groups of airlines together as well as specific gate allocations to airlines.

PASSENGER TIMING SIMULATION

CURBSIDE - DEPARTURE PASSENGER TIMING EVENT GENERATION

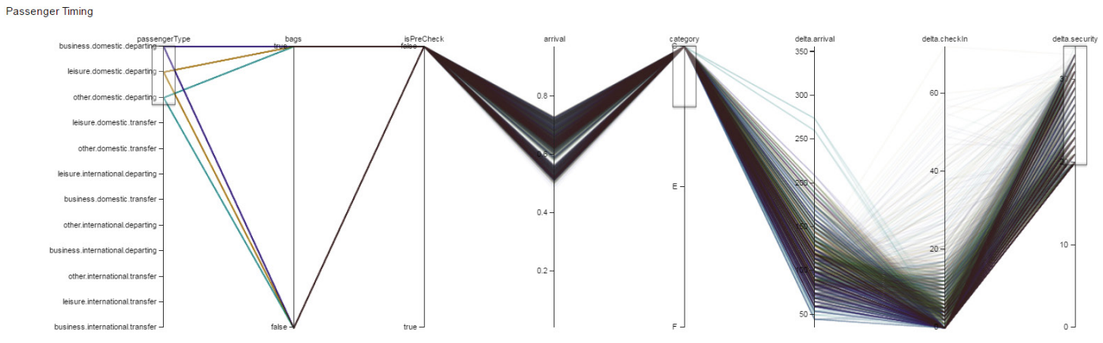
Using the pre-computed passenger types and aircraft types unique to the airport, and coupled with the design day flight schedule and design scheme variables, the preliminary passenger timing simulation produces a set of passengers corresponding to the test load factor for every flight out of the airport 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



DOMESTIC TYPE C PASSENGER TIMING FILTERED BY CHECK-IN TIME

Passenger check-in times are algorithmically driven using bespoke in house Superspace methods, and are a function of the ARCP's LoS standards for accepatble queuing times and processing rates at check-in kiosks. This could be used to test various combinations of check-in kiosks and the corresponding effect on queuing times. Passenger arrival distribution rates and the percentage of passengers checking in bags versus carry-on only are derived from the pre-computed profile specific to the flight type (i.e. domestic type C / international type F), load factor, and time of day (also a function of the flight profile - pre 9AM vs post 9AM).



DOMESTIC TYPE C PASSENGER TIMING FILTERED BY SECURITY TIME

Similarly, passenger security times are driven by passenger flow from check-in to security for all emplaning flights at a given time slice delta, as well as the current design scheme's security unit capacity. Flow rates are assumed to be around 140 passengers per hour per security unit (ARCP), or 1 passenger every 140/(60*n units) * delta. Variable security unit counts are implemented, as the current SFO design scheme provides a base of 10 security units for all passengers, with an additional 6 available to passengers without checked bags.

delta.change rates are not reflective of actual times from check-in to security. They are representative of the cumulative delay to passengers assuming a regular flow rate and walk times between events, so how much longer from 0 minutes the passenger will wait. For example, a passenger with an average security processing time of 30 sec, 5 min walk to security, and a **delta.security of 4 min** would have an actual time of 9.5 min from check-in to concourse.

>> PASSENGER PROFILE SIMULATION

All — Terminal

Run

TOTAL PASSENGER PROFILES — Show Results

UNIQUE PASSENGER PROFILES — Show Results

AIRCRAFT PROFILES — Show Results

>> PASSENGER TIMING SIMULATION

0.9 — Load Factor

0 to 24 — Time Frame

American Airlines — Filter Flights

leisure.departing — Filter Passengers

Run

FLIGHTS — Show Results

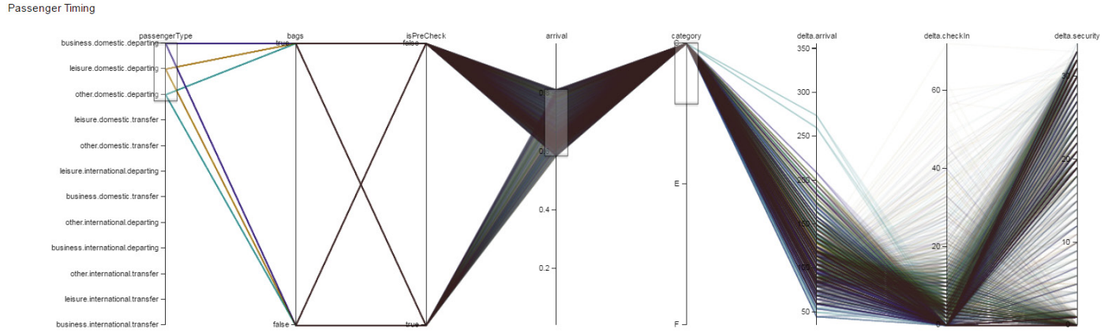
PASSENGERS — Hide Results

Save

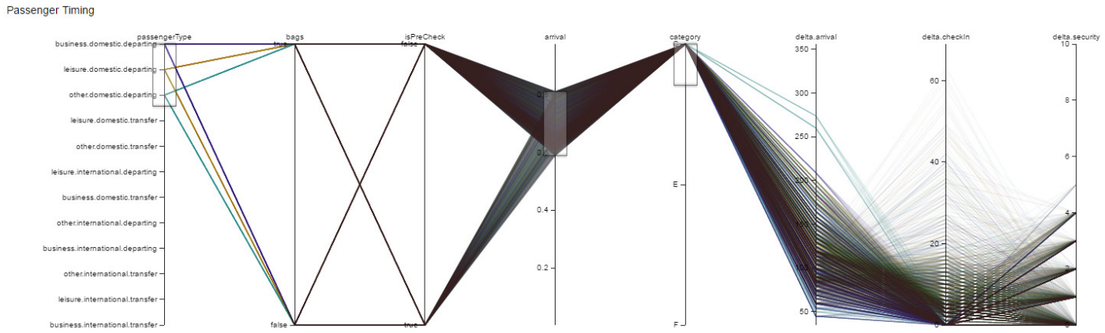
passengers.csv passengers.json

Name	Gender	Bags	Pre Check	Flight ID	Arrival	Security	Concourse	Gate	Boarding	Departure
all.business.domestic.departing	F	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	06:06:00	06:06:00	06:14:00	06:39:00	06:38:00	06:00:00
all.business.domestic.departing	M	false	true	f1f4985-4bb6-4966-9ae1-1a222894e33	05:01:00	05:01:00	05:01:00	05:37:00	05:47:00	06:00:00
all.business.domestic.departing	M	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	05:00:00	05:00:00	05:06:00	05:44:00	05:48:00	06:00:00
all.business.domestic.departing	F	true	true	f1f4985-4bb6-4966-9ae1-1a222894e33	05:00:00	05:04:00	05:04:00	05:40:00	05:48:00	06:00:00
all.business.domestic.departing	M	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:54:00	04:54:00	04:58:00	05:27:00	05:45:00	06:00:00
all.business.domestic.departing	F	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:51:00	04:51:00	04:55:00	05:27:00	05:40:00	06:00:00
all.business.domestic.departing	M	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:51:00	04:51:00	04:56:00	05:42:00	05:42:00	06:00:00
all.business.domestic.departing	F	false	true	f1f4985-4bb6-4966-9ae1-1a222894e33	04:46:00	04:46:00	04:46:00	05:39:00	05:48:00	06:00:00
all.business.domestic.departing	F	false	true	f1f4985-4bb6-4966-9ae1-1a222894e33	04:45:00	04:45:00	04:45:00	05:39:00	05:42:00	06:00:00
all.business.domestic.departing	F	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:41:00	04:41:00	04:44:00	05:37:00	05:47:00	06:00:00
all.business.domestic.departing	F	false	true	f1f4985-4bb6-4966-9ae1-1a222894e33	04:40:00	04:40:00	04:40:00	04:40:00	05:48:00	06:00:00
all.business.domestic.departing	M	true	true	f1f4985-4bb6-4966-9ae1-1a222894e33	04:39:00	04:54:00	04:54:00	05:42:00	05:45:00	06:00:00
all.business.domestic.departing	F	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:37:00	04:50:00	04:54:00	05:41:00	05:43:00	06:00:00
all.business.domestic.departing	F	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:38:00	04:38:00	04:38:00	04:38:00	05:48:00	06:00:00
all.business.domestic.departing	M	false	true	f1f4985-4bb6-4966-9ae1-1a222894e33	04:38:00	04:38:00	04:38:00	05:35:00	05:47:00	06:00:00
all.business.domestic.departing	F	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:30:00	04:30:00	04:33:00	05:39:00	05:39:00	06:00:00
all.business.domestic.departing	F	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:30:00	04:38:00	04:41:00	05:29:00	05:45:00	06:00:00
all.business.domestic.departing	F	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:30:00	04:30:00	04:34:00	05:40:00	05:47:00	06:00:00
all.business.domestic.departing	F	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:30:00	04:40:00	04:44:00	05:33:00	05:43:00	06:00:00
all.business.domestic.departing	M	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:26:00	04:26:00	04:28:00	05:41:00	05:45:00	06:00:00
all.business.domestic.departing	F	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:26:00	04:26:00	04:26:00	05:37:00	05:44:00	06:00:00
all.business.domestic.departing	F	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:24:00	04:36:00	04:36:00	05:35:00	05:45:00	06:00:00
all.business.domestic.departing	F	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:22:00	04:32:00	04:34:00	05:43:00	05:48:00	06:00:00
all.business.domestic.departing	F	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:21:00	04:26:00	04:26:00	05:44:00	05:49:00	06:00:00
all.business.domestic.departing	M	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:21:00	04:30:00	04:33:00	05:35:00	05:44:00	06:00:00
all.business.domestic.departing	F	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:20:00	04:24:00	04:24:00	05:35:00	05:49:00	06:00:00
all.business.domestic.departing	F	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:16:00	04:20:00	04:23:00	05:40:00	05:48:00	06:00:00
all.business.domestic.departing	F	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:16:00	04:16:00	04:16:00	05:42:00	05:48:00	06:00:00
all.business.domestic.departing	F	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:09:01	04:15:00	04:17:00	05:39:00	05:43:00	06:00:00
all.business.domestic.departing	F	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:09:01	04:09:01	04:10:01	05:39:00	05:39:00	06:00:00
all.business.domestic.departing	F	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:04:59	04:04:59	04:04:59	05:32:00	05:46:00	06:00:00
all.business.domestic.departing	M	false	true	f1f4985-4bb6-4966-9ae1-1a222894e33	04:04:59	04:04:59	04:04:59	04:04:59	05:43:00	06:00:00
all.business.domestic.departing	F	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:04:59	04:04:59	04:05:59	05:38:00	05:44:00	06:00:00
all.business.domestic.departing	M	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:03:00	04:03:00	04:03:00	05:27:00	05:48:00	06:00:00
all.business.domestic.departing	M	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:01:00	04:01:00	04:02:00	05:41:00	05:44:00	06:00:00
all.business.domestic.departing	F	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:01:00	04:01:00	04:01:00	05:33:00	05:46:00	06:00:00
all.business.domestic.departing	M	false	true	f1f4985-4bb6-4966-9ae1-1a222894e33	04:00:00	04:00:00	04:00:00	05:22:00	05:46:00	06:00:00
all.business.domestic.departing	M	false	true	f1f4985-4bb6-4966-9ae1-1a222894e33	04:00:00	04:00:00	04:00:00	05:20:00	05:48:00	06:00:00
all.business.domestic.departing	M	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	03:55:01	03:55:01	03:55:01	03:55:01	05:46:00	06:00:00
all.business.domestic.departing	F	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	03:54:01	03:54:01	03:54:01	05:43:00	05:46:00	06:00:00
all.business.domestic.departing	F	false	true	f1f4985-4bb6-4966-9ae1-1a222894e33	03:49:01	03:49:01	03:49:01	05:29:00	05:40:00	06:00:00
all.business.domestic.departing	F	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	03:46:00	03:46:00	03:46:00	05:41:00	05:48:00	06:00:00
all.business.domestic.departing	M	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	03:45:00	03:49:01	03:49:01	03:49:01	05:45:00	06:00:00
all.business.domestic.departing	M	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	03:40:59	03:44:00	03:44:00	05:34:00	05:48:00	06:00:00
all.business.domestic.departing	M	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	03:39:59	03:39:59	03:39:59	05:31:00	05:41:00	06:00:00
all.business.domestic.departing	M	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	03:34:59	03:34:59	03:36:59	05:43:00	05:47:00	06:00:00
all.business.domestic.departing	F	true	true	f1f4985-4bb6-4966-9ae1-1a222894e33	03:30:00	03:34:00	03:34:00	05:38:00	05:48:00	06:00:00
all.business.domestic.departing	M	false	true	f1f4985-4bb6-4966-9ae1-1a222894e33	03:29:00	03:29:00	03:29:00	05:30:00	05:49:00	06:00:00
all.business.domestic.departing	F	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	03:26:00	03:26:00	03:26:00	05:28:00	05:40:00	06:00:00
all.business.domestic.departing	M	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	03:21:00	03:26:00	03:26:00	03:26:00	05:40:00	06:00:00
all.business.domestic.departing	F	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	03:18:00	03:18:00	03:18:00	05:36:00	05:47:00	06:00:00
all.business.domestic.departing	M	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	03:04:01	03:08:01	03:08:01	03:08:01	05:44:00	06:00:00
all.business.domestic.departing	M	true	true	f1f4985-4bb6-4966-9ae1-1a222894e33	02:54:00	02:56:00	02:56:00	05:24:00	05:43:00	06:00:00
all.business.domestic.departing	M	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	02:45:00	02:45:00	02:46:00	05:44:00	05:47:00	06:00:00
all.business.domestic.transfer	M	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	03:21:00	03:21:00	03:21:00	05:39:00	05:48:00	06:00:00
all.business.domestic.transfer	F	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	02:02:00	02:02:00	02:02:00	02:02:00	05:45:00	06:00:00
all.business.domestic.transfer	M	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	01:44:00	01:44:00	01:44:00	05:32:00	05:47:00	06:00:00
all.leisure.domestic.departing	M	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	05:00:00	05:07:00	05:16:00	05:34:00	05:48:00	06:00:00
all.leisure.domestic.departing	M	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:51:00	05:04:00	05:10:00	05:42:00	05:46:00	06:00:00
all.leisure.domestic.departing	M	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:46:00	05:00:00	05:05:00	05:42:00	05:46:00	06:00:00
all.leisure.domestic.departing	M	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:45:00	04:57:00	05:03:00	05:03:00	05:43:00	06:00:00
all.leisure.domestic.departing	M	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:40:00	04:54:00	04:57:00	05:36:00	05:39:00	06:00:00
all.leisure.domestic.departing	M	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:36:00	04:36:00	04:40:00	04:40:00	05:49:00	06:00:00
all.leisure.domestic.departing	M	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:36:00	04:49:00	04:53:00	05:17:00	05:40:00	06:00:00
all.leisure.domestic.departing	F	false	true	f1f4985-4bb6-4966-9ae1-1a222894e33	04:36:00	04:36:00	04:36:00	05:42:00	05:48:00	06:00:00
all.leisure.domestic.departing	M	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:33:00	04:41:00	04:44:00	05:41:00	05:48:00	06:00:00
all.leisure.domestic.departing	M	true	true	f1f4985-4bb6-4966-9ae1-1a222894e33	04:30:00	04:36:00	04:36:00	04:36:00	05:44:00	06:00:00
all.leisure.domestic.departing	M	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:30:00	04:46:00	04:49:00	05:43:00	05:43:00	06:00:00
all.leisure.domestic.departing	F	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:30:00	04:30:00	04:33:00	05:34:00	05:48:00	06:00:00
all.leisure.domestic.departing	M	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:26:00	04:26:00	04:27:00	05:17:00	05:48:00	06:00:00
all.leisure.domestic.departing	F	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:21:00	04:21:00	04:24:00	05:44:00	05:44:00	06:00:00
all.leisure.domestic.departing	F	true	true	f1f4985-4bb6-4966-9ae1-1a222894e33	04:21:00	04:29:00	04:29:00	05:31:00	05:48:00	06:00:00
all.leisure.domestic.departing	M	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:20:00	04:27:00	04:29:00	05:34:00	05:43:00	06:00:00
all.leisure.domestic.departing	M	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:16:00	04:22:00	04:24:00	05:24:00	05:49:00	06:00:00
all.leisure.domestic.departing	M	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:16:00	04:16:00	04:17:00	04:17:00	05:44:00	06:00:00
all.leisure.domestic.departing	M	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:09:01	04:19:00	04:20:00	05:38:00	05:48:00	06:00:00
all.leisure.domestic.departing	M	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:09:01	04:19:00	04:19:00	05:41:00	05:47:00	06:00:00
all.leisure.domestic.departing	M	false	true	f1f4985-4bb6-4966-9ae1-1a222894e33	04:09:01	04:09:01	04:09:01	04:09:01	05:46:00	06:00:00
all.leisure.domestic.departing	F	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:06:59	04:14:00	04:15:00	05:29:00	05:46:00	06:00:00
all.leisure.domestic.departing	F	false	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:04:59	04:04:59	04:04:59	04:04:59	05:48:00	06:00:00
all.leisure.domestic.departing	F	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:01:00	04:09:01	04:10:01	05:42:00	05:48:00	06:00:00
all.leisure.domestic.departing	F	true	true	f1f4985-4bb6-4966-9ae1-1a222894e33	04:01:00	04:13:00	04:13:00	05:41:00	05:42:00	06:00:00
all.leisure.domestic.departing	F	false	true	f1f4985-4bb6-4966-9ae1-1a222894e33	04:00:00	04:00:00	04:00:00	04:00:00	05:48:00	06:00:00
all.leisure.domestic.departing	M	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:00:00	04:08:59	04:08:59	05:40:00	05:40:00	06:00:00
all.leisure.domestic.departing	M	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	04:00:00	04:08:01	04:08:01	05:39:00	05:45:00	06:00:00
all.leisure.domestic.departing	F	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	03:59:00	04:01:00	04:02:00	05:30:00	05:48:00	06:00:00
all.leisure.domestic.departing	F	true	false	f1f4985-4bb6-4966-9ae1-1a222894e33	03:54:01	03:58:00	03:58:00	05:43:00	05:47:00	06:00:00

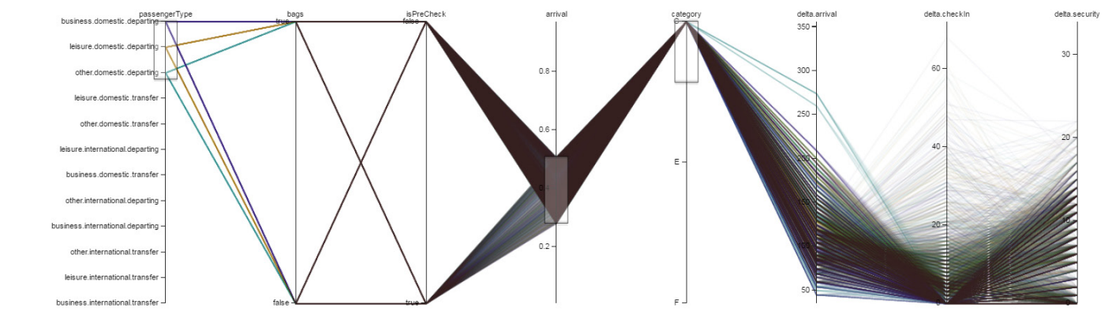
SIMULATED PASSENGER OUTPUT WITH EVENT TIMINGS AND PROFILE ATTRIBUTES



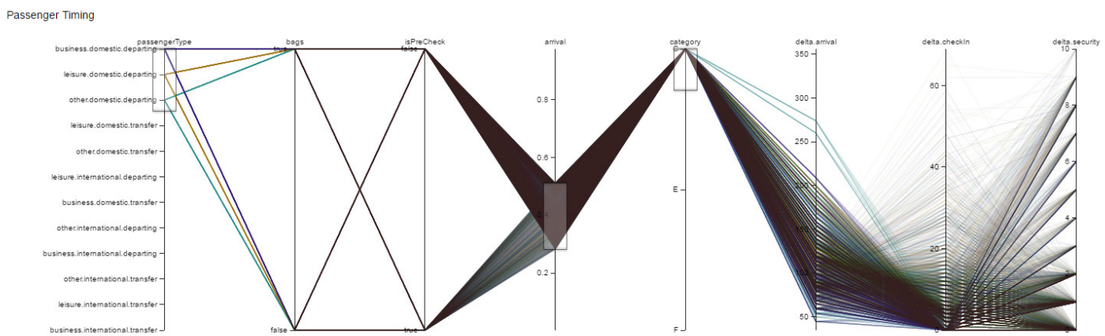
DOMESTIC PASSENGER SECURITY TIMES | AFTERNOON PEAK - SCHEME I (10/12 SECURITY LINES)



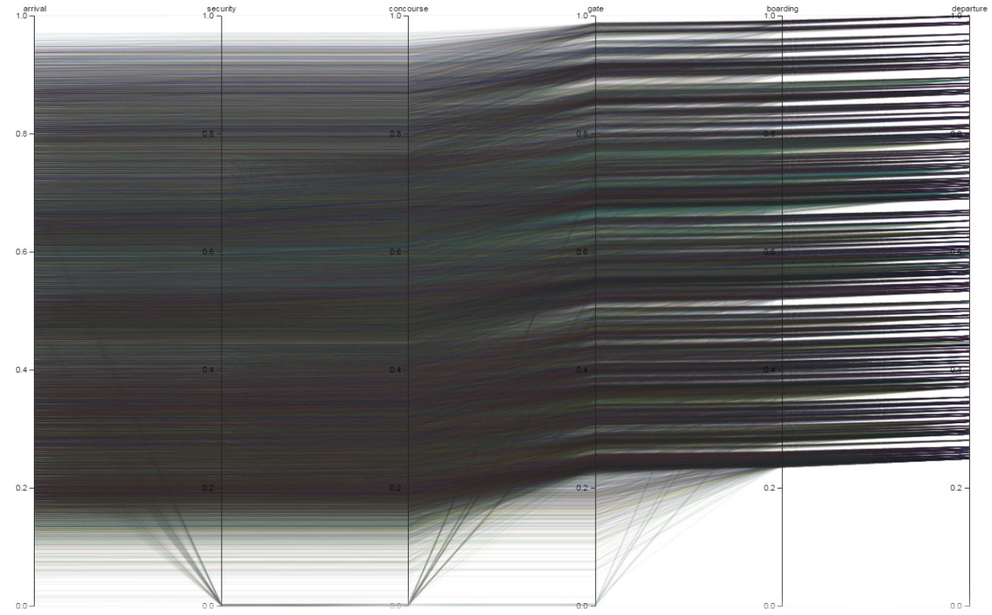
DOMESTIC PASSENGER SECURITY TIMES | AFTERNOON PEAK - SCHEME II (10/16 SECURITY LINES)



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

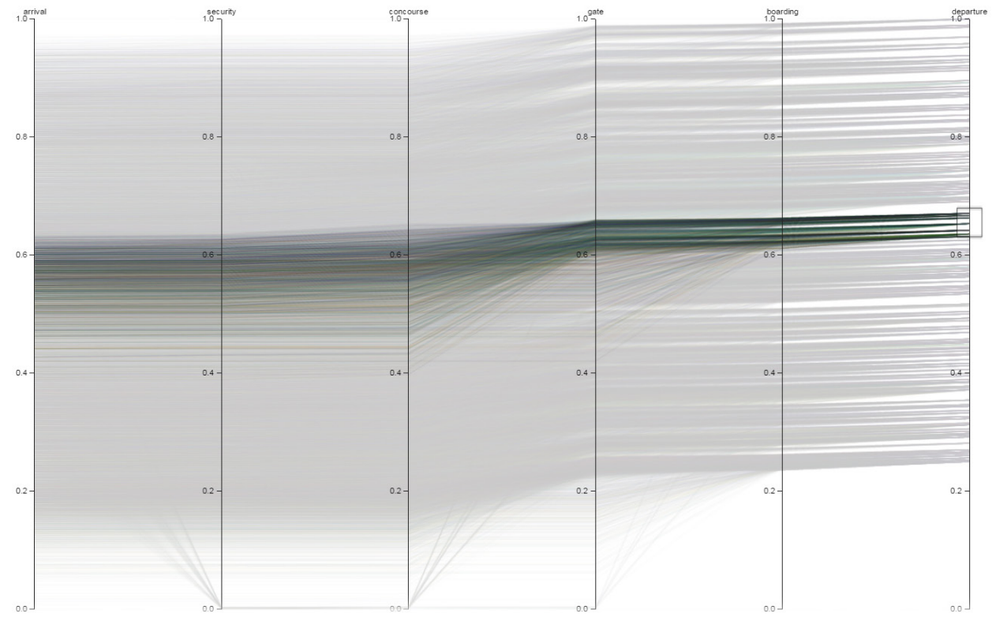


DOMESTIC PASSENGER SECURITY TIMES | MORNING PEAK - SCHEME II (10/16 SECURITY LINES)



TOTAL SIMULATED DESIGN DAY 2023 FLIGHT PASSENGERS - FLOW FROM CURBSIDE TO DEPARTURE

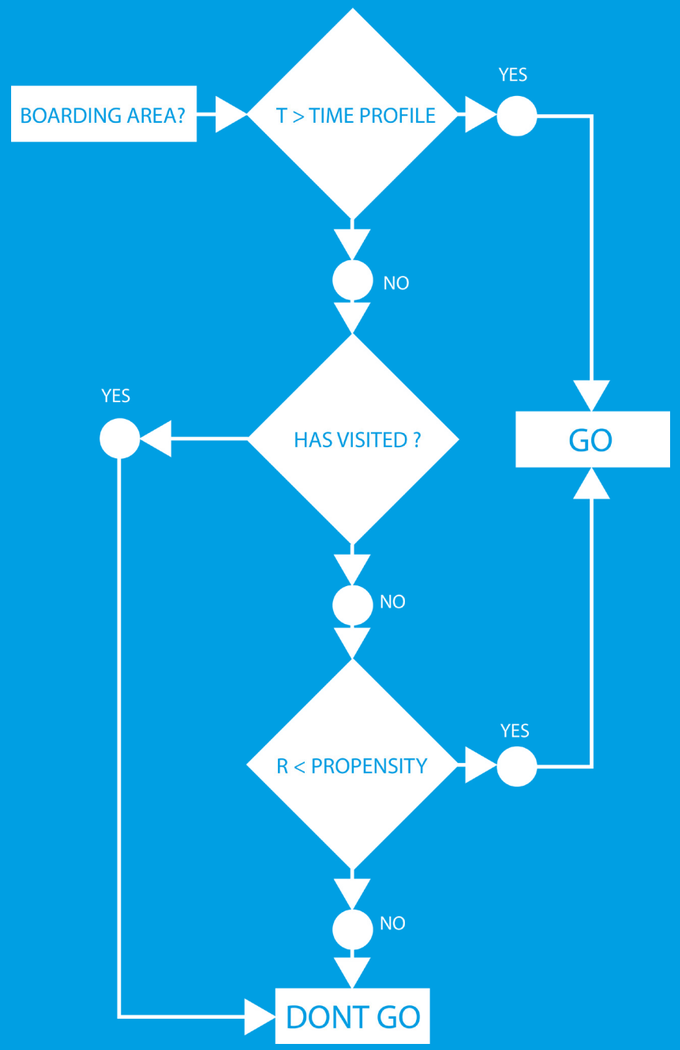
The images on the left show the changes in security times between two different schemes - one with a base 10 + 2 units, and the other with a base 10 + 6 units (current scheme). The top two images are filtered to afternoon peak hours, and the bottom are filtered to morning peak hours. The images above and below are total passenger flow through the airport for the current design scheme and design day flights.



PASSENGERS FILTERED BY DEPARTURE TIME - FLOW FROM CURBSIDE TO DEPARTURE

03

Passenger Spatial Simulation



The passenger spatial model simulates occupational patterns and behaviors on the air-side of a given airport design scheme configuration.

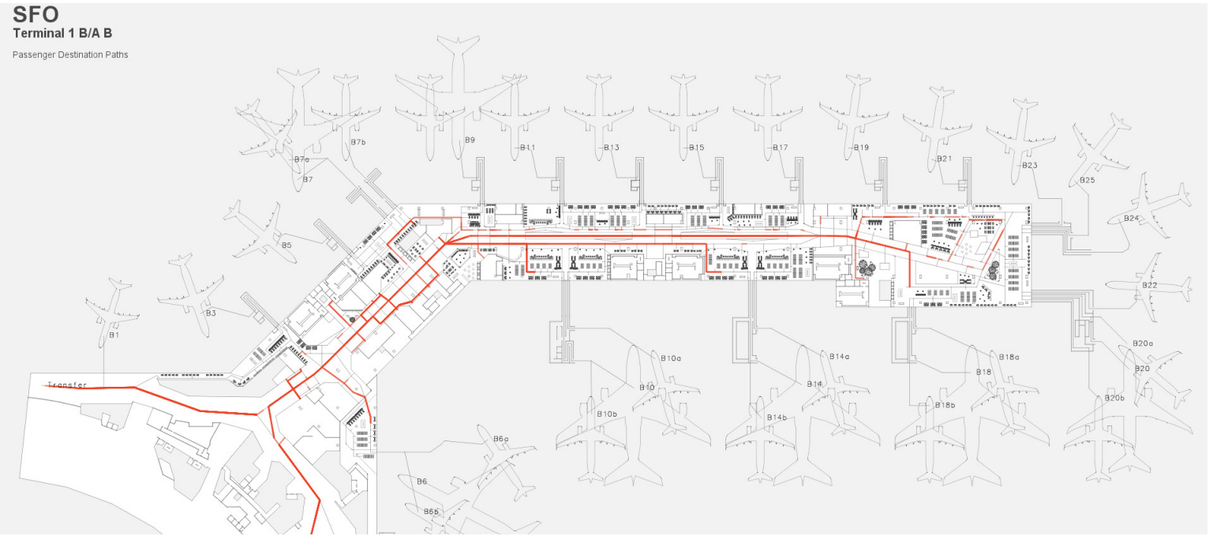
Using the timing profiles for each passenger's overall airport journey events, and the specifications for each unique passenger type, the system outputs a spatial representation of the total occupation and usage of the design layout for:

- Seating configurations
- Retail/concessions/F&B
- Bathrooms
- Access/pathways
- Hold room occupancy/arrival rates
- Visibility/distances

PASSENGER SPATIAL SIMULATION

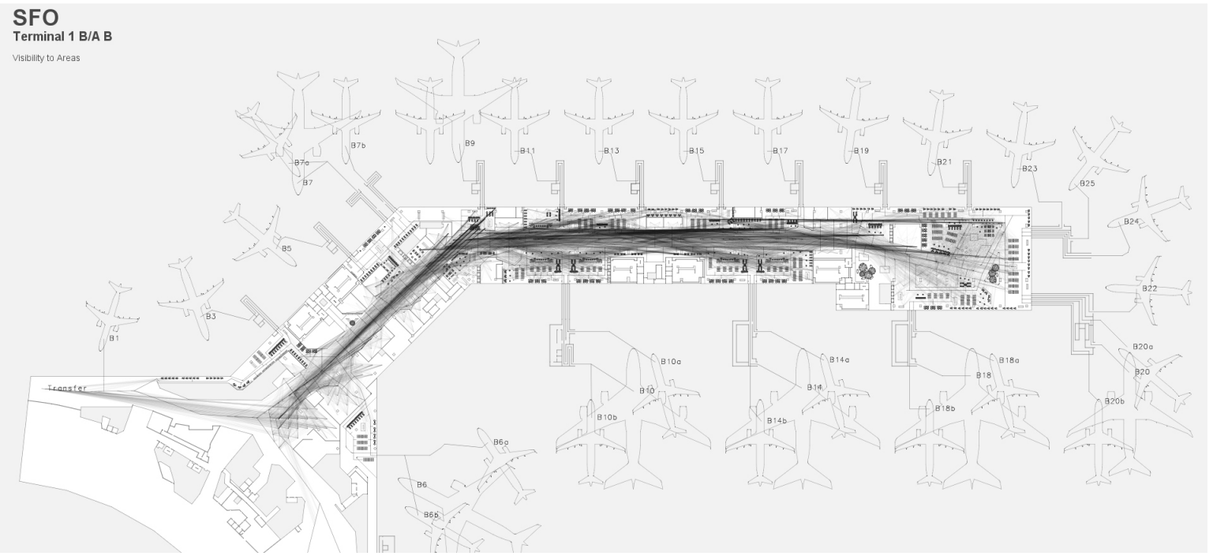
PASSENGER BEHAVIOR

With a spatial graph representation of the scheme, and using the generated timing profiles, we can simulate more detailed behaviors for each passenger moving through the departure lounge. This can be done by combining definitions of passenger types with inherent spatial properties such as visibility and distance to the target in order to improve the decision making process.

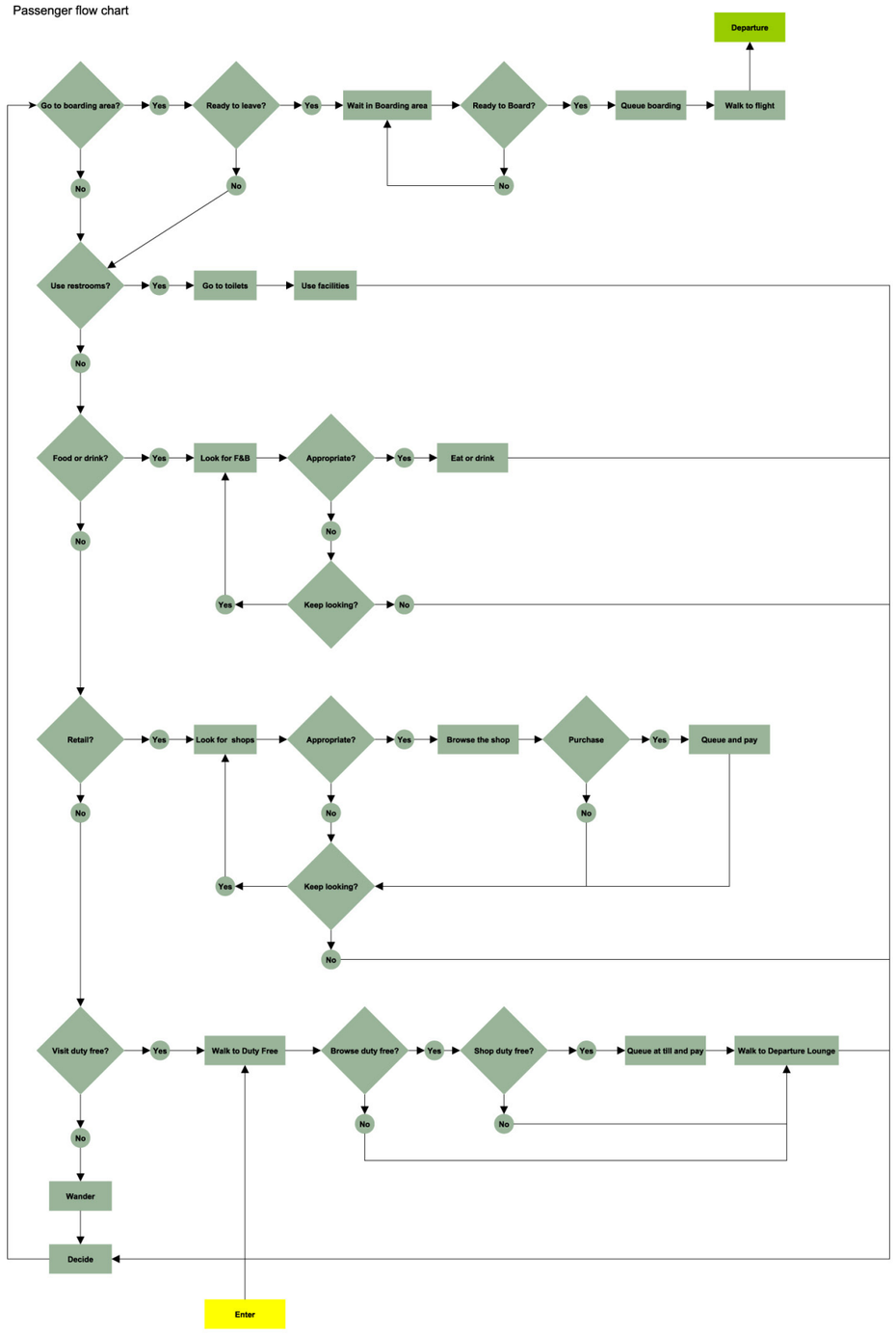


DESIGN SCHEME SPATIAL GRAPH AND PASSENGER DECISION PATHS

The image to the right is an example of a passenger journey flow chart. The individual journey is determined according to passenger type, generic behaviour, and spatial conditions. Diamond nodes represent individual decisions that the passenger can make. Round nodes represent potential outcomes of that decision (boolean yes | no), and rectangles represent action resulting from that decision. For each desision, an evaluation of the passenger profile and propensities is used to weight the best outcome.



DESIGN SCHEME VISIBILITY FROM GRAPH NODE LOCATIONS

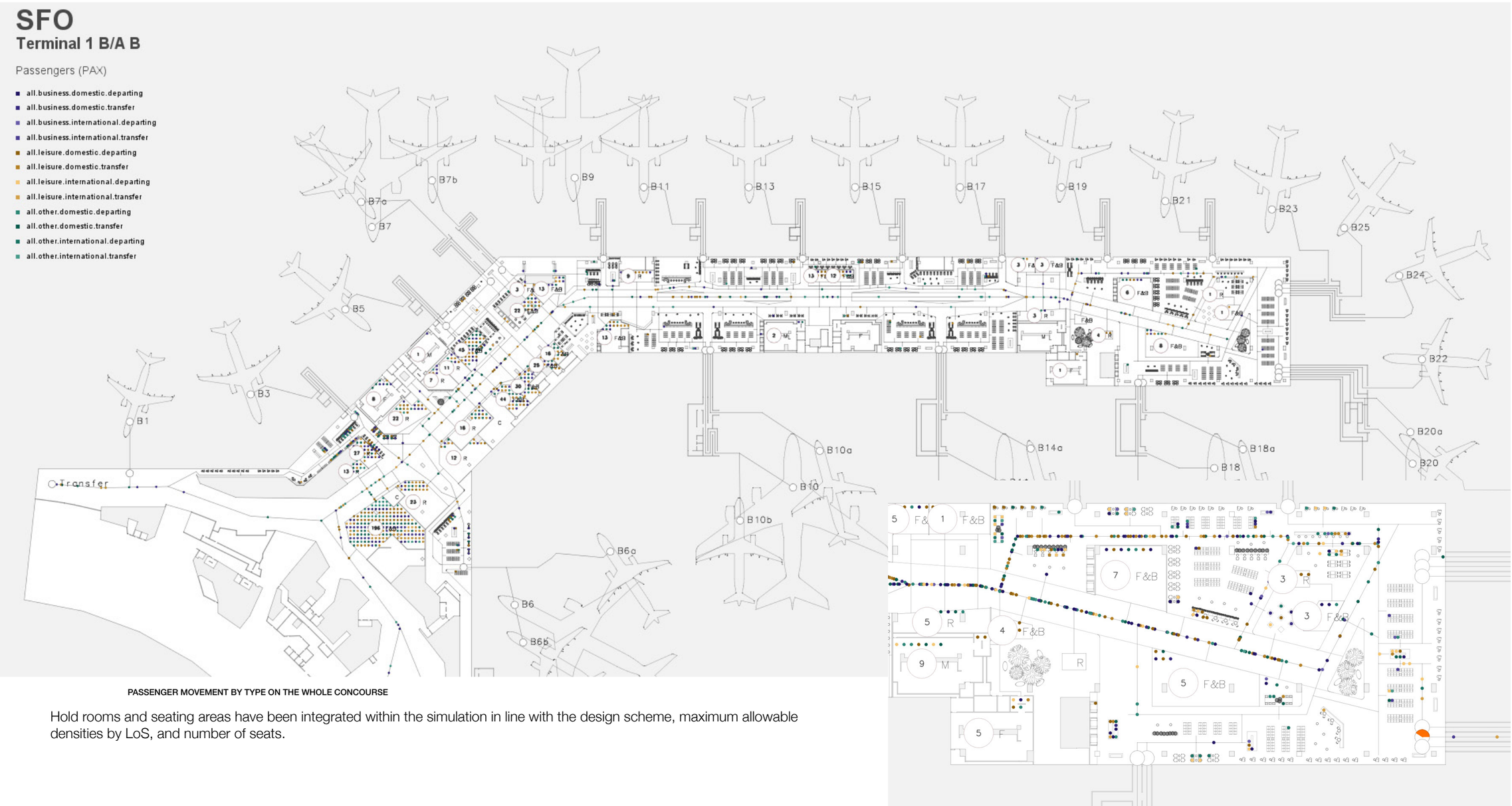


PASSENGER JOURNEY FLOW CHART

PASSENGER SPATIAL SIMULATION

PASSENGER MOVEMENT

Passenger movement and spatial usage on the air-side of the design scheme can be visualized by passenger type and by retail type. Propensities of different passengers towards different retail/FnB/concessions allows for a visualization of possible occupation patterns for a given gate scheme/design day flight schedule.



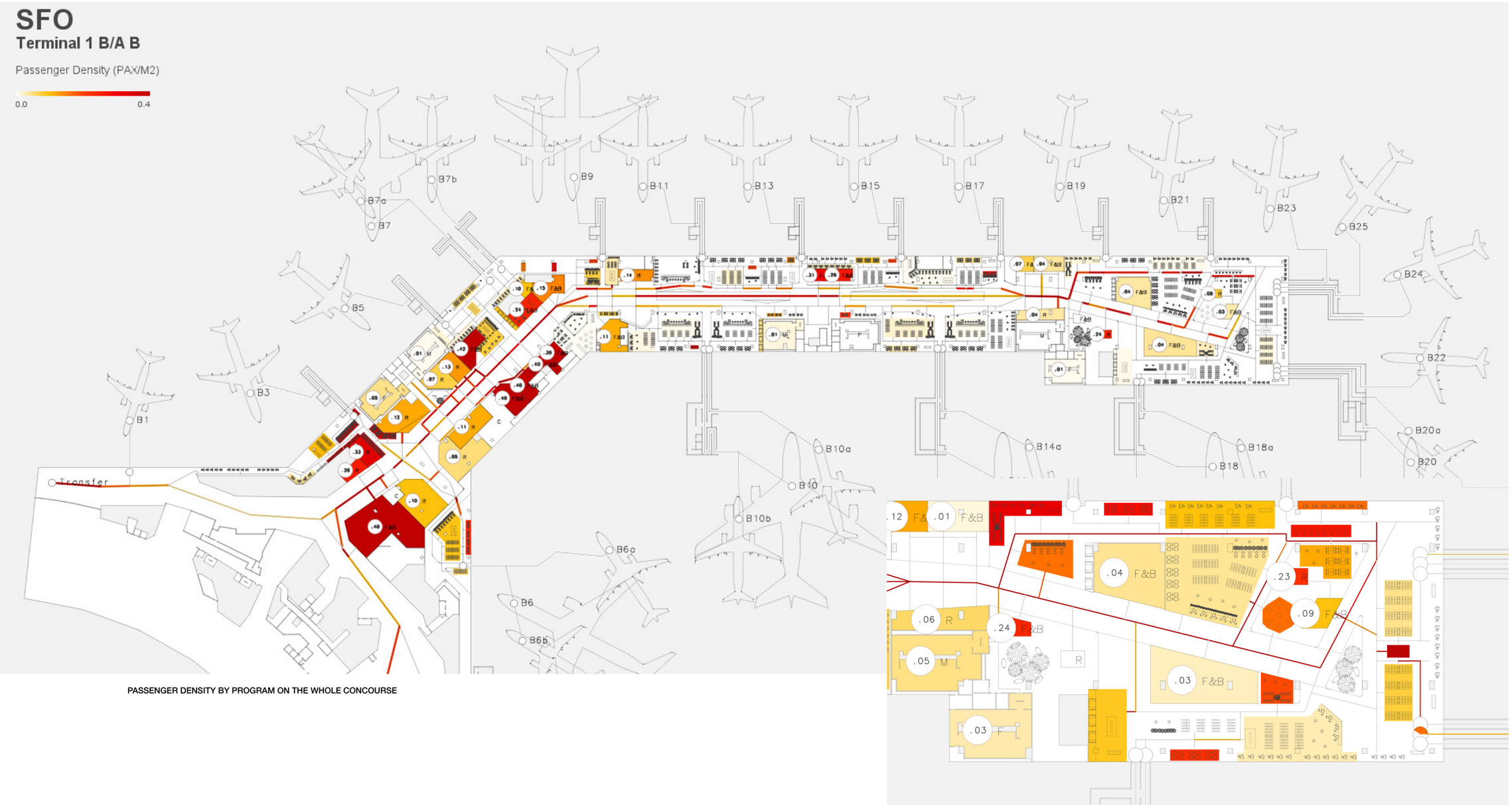
PASSENGER MOVEMENT BY TYPE ON THE WHOLE CONCOURSE

Hold rooms and seating areas have been integrated within the simulation in line with the design scheme, maximum allowable densities by LoS, and number of seats.

PASSENGER MOVEMENT BY TYPE ON THE END OF CONCOURSE

PASSENGER SPATIAL SIMULATION

PASSENGER DENSITY

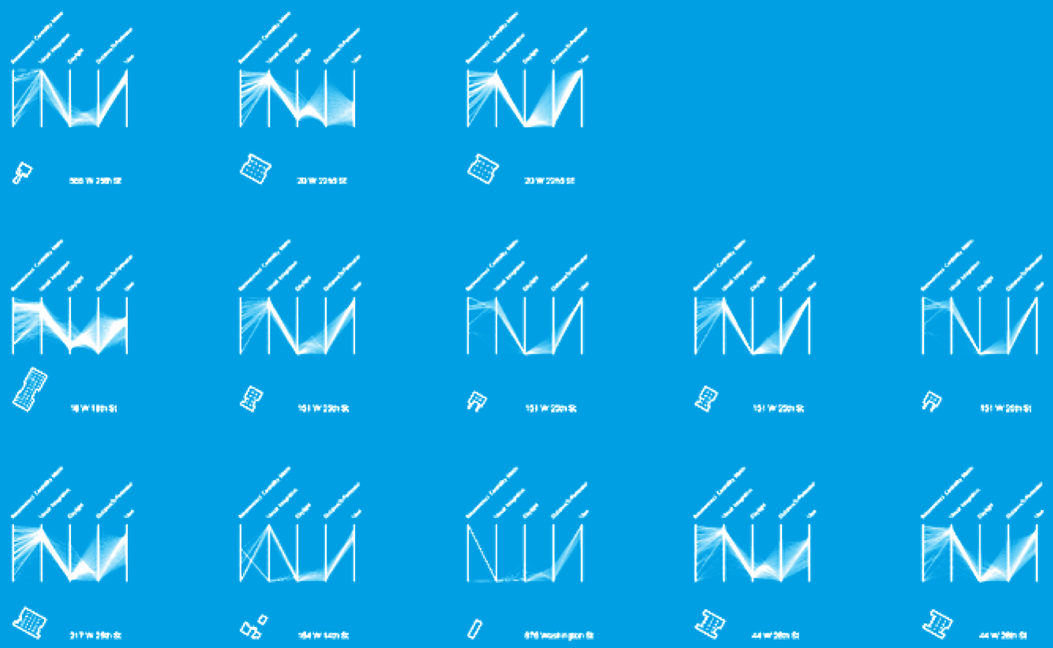


PASSENGER DENSITY BY PROGRAM ON THE WHOLE CONCOURSE

PASSENGER DENSITY BY PROGRAM ON THE END OF CONCOURSE

04

Benchmarking



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- Access/pathways
- Hold room occupancy/arrival rates
- Visibility/distances