a database design proposal for UNITED

wallance miranda

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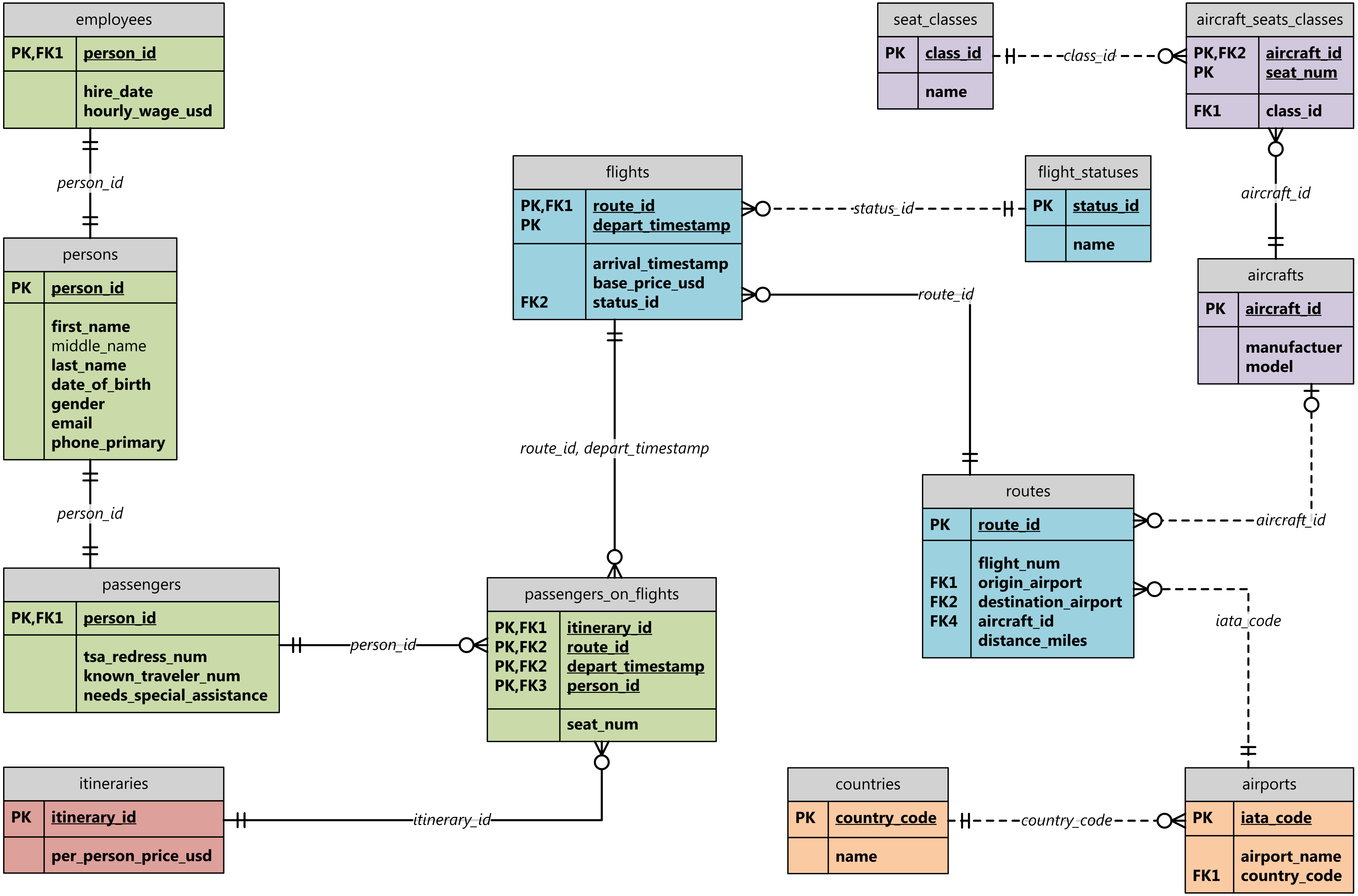
executive summary

With over 144 million passengers a year traveling between 372 worldwide destinations, United Airlines needs a database that with all the data for the passengers. Security is especially critical in this design. The data must be accessible by the appropriate persons in the traveling process, as well as customers. Due to federal regulations, the data must be accurate and consistent. Inconsistent data is unacceptable.

The design focuses on the tables that are necessary to book flights. This data includes: passengers, passenger itineraries, employees, flights, and aircraft seating. The design assumes that United does not have any airline partners, in which they share flights.

An overview of the database will be presented, followed by the details of how each of the database tables will be created. Each table will be followed with a table of sample data. Ideal database user roles will be suggested and their purposes will be explained. To assist in the mission of data integrity, a trigger will be shown and explained. To see how meaningful data can be retrieved, sample reports will be shown. More details about the implementation are provided towards the end of the proposal. Like any design or product, improvements and new features are needed, so they will be explained.

This design was targeted for and tested on PostgreSQL 9.2.4, which was released on April 4th 2013.



employees

PK,FK1	person_id
	hire_date hourly_wage_usd

persons

PK	person_id
	first_name middle_name last_name date_of_birth gender email phone_primary

passengers

PK,FK1	person_id
	tsa_redress_num known_traveler_num needs_special_assistance

itineraries

PK	itinerary_id
	per_person_price_usd

flights

PK,FK1 PK	route_id depart_timestamp
  FK2	arrival_timestamp base_price_usd status_id

passengers_on_flights

PK,FK1 PK,FK2 PK,FK2 PK,FK3	itinerary_id route_id depart_timestamp person_id
	seat_num

seat_classes

PK	class_id
	name

aircraft_seats_classes

PK,FK2 PK	aircraft_id seat_num
FK1	class_id

flight_statuses

PK	status_id
	name

aircrafts

PK	aircraft_id
	manufactuer model

routes

PK	route_id
 FK1 FK2 FK4	flight_num origin_airport destination_airport aircraft_id distance_miles

countries

PK	country_code
	name

airports

PK	iata_code
 FK1	airport_name country_code

entity relationship diagram

persons table

Since employees may also be passengers (and not working as a pilot or flight attendant) and passengers may also be employees, their basic information (i.e. name and phone number) is separated into this table.

```
CREATE TABLE IF NOT EXISTS persons (
     person_id           SERIAL         NOT NULL UNIQUE,
     first_name          VARCHAR(50)    NOT NULL,
     middle_name         VARCHAR(50)    NOT NULL,
     last_name           VARCHAR(50)    NOT NULL,
     date_of_birth       DATE           NOT NULL,
     gender              CHAR(1)        NOT NULL,
     email               VARCHAR(256)   NOT NULL,
     phone_primary       CHAR(15)  NOT NULL,
     CONSTRAINT valid_gender   CHECK (gender = 'M' OR gender = 'F'),
     PRIMARY KEY (person_id)
);
```

functional dependencies

person_id → first_name, middle_name, last_name, date_of_birth, gender, email, phone_primary

sample data

person_id	first_name	middle_name	last_name	date_of_birth	gender	email	phone_primary
1	Juliet	Maria	Banks	1992-02-10	F	juliet@gmail.com	808-222-4255
2	Alexander	William	Arnold	1956-06-09	M	alexander@yahoo.com	212-689-9722
3	Deborah	Josephine	Clark	1990-08-30	F	deborah@me.com	845-436-7954
4	Jeffrey	Domin	Garces	1975-05-18	M	jeffrey@icloud.com	310-514-9791
5	Eileen		Anderson	1994-12-15	F	eileen@hotmail.com	424-689-7547
6	Rosalie	Nancy	Morgan	1997-01-23	F	rosalie@gmail.com	808-239-4133
7	Sean	Jacob	Domingo	1955-03-13	M	sean@icloud.com	970-569-1583
8	Susan		Freeman	1983-10-31	F	susan@yahoo.com	630-712-6948
9	Bryan	Colvin	Davis	2005-06-16	M	bryan@gmail.com	717-378-1987

employees table

```
CREATE TABLE IF NOT EXISTS employees (
     person_id           INTEGER        NOT NULL,
     hire_date           DATE      NOT NULL DEFAULT CURRENT_TIMESTAMP,
     hourly_wage_usd               MONEY          NOT NULL,
     PRIMARY KEY (person_id),
     FOREIGN KEY (person_id)  REFERENCES persons(person_id)
);
```

functional dependencies

person_id → hire_date, hourly_wage_usd

sample data

person_id	hire_date	hourly_wage_usd
4	1995-02-21	25.32
2	1972-06-14	34.25
8	1991-04-18	30.15
3	2013-01-31	28.44
7	1992-11-13	26.75

create table statements

passengers table

```
CREATE TABLE IF NOT EXISTS passengers (
     person_id                     INTEGER        NOT NULL,
     tsa_redress_num               CHAR(13)       NOT NULL UNIQUE DEFAULT '',
     known_traveler_num            CHAR(25)       NOT NULL UNIQUE DEFAULT '',
     needs_special_assistance      BOOLEAN        NOT NULL DEFAULT FALSE,
     PRIMARY KEY (person_id),
     FOREIGN KEY (person_id)       REFERENCES persons(person_id)
);
```

functional dependencies

<u>person_id</u> → tsa_redress_num, known_traveler_num, needs_special_assistance

sample data

person_id	tsa_redress_num	known_traveler_num	needs_special_assistance
1			false
2	HX592047501US		true
3		HE97965481233	false
4	JK497368125US		false
5		777700757	true
6		347934681289	false
7			false
8			false
9			true

create table statements

aircrafts table

The list of the possible aircraft models used for a particular route.

```
CREATE TABLE IF NOT EXISTS aircrafts (
     aircraft_id         SERIAL         NOT NULL,
     manufacturer        VARCHAR(25)    NOT NULL,
     model               VARCHAR(15)    NOT NULL,
     PRIMARY KEY (aircraft_id)
);
```

functional dependencies

aircraft_id → manufacturer, model

sample data

aircraft_id	manufacturer	model
1	Boeing	767-300ER
2	Airbus	A330
3	Bombardier	CRJ700
4	Embraer	ERJ145

seat_classes table

The list of the possible seat classes for a particular aircraft's seat number.

```
CREATE TABLE IF NOT EXISTS seat_classes (
     class_id       SERIAL         NOT NULL,
     name           VARCHAR(25)    NOT NULL,
     PRIMARY KEY (class_id)
);
```

functional dependencies

class_id → name

sample data

class_id	name
1	Economy
2	Economy Plus
3	First Class
4	Business Class

aircraft_seats table

The list of seat numbers for a particular model of an aircraft.

```
CREATE TABLE IF NOT EXISTS aircraft_seats (
     aircraft_id              INTEGER        NOT NULL,
     seat_num                 VARCHAR(3)     NOT NULL,
     class_id                 INTEGER        NOT NULL,
     PRIMARY KEY (aircraft_id, seat_num),
     FOREIGN KEY (aircraft_id)     REFERENCES aircrafts(aircraft_id),
     FOREIGN KEY (class_id)        REFERENCES seat_classes(class_id)
);
```

functional dependencies

aircraft_id, seat_num → class_id

sample data

aircraft_id	seat_num	class_id
1	1A	3
1	1B	3
1	1C	3
1	1D	3
1	14A	2
1	14B	2
1	14C	2
1	14D	2
1	20A	1
2	18A	2
2	18B	2
2	18C	2
2	18D	2
2	22A	1
2	22B	1
2	22C	1
2	22D	1
2	31A	1
2	10A	2
1	10B	2
1	10C	2
1	10D	2
1	11A	2
1	11B	2
1	11C	2
1	11D	2
1	28A	1
1	30A	1
1	30B	1
1	30C	1
1	30D	1
1	31A	1
1	31B	1
1	31C	1
1	31D	1
1	32A	1

countries table

Contains the list of countries where an airport may be located.

```
CREATE TABLE IF NOT EXISTS countries (
     country_code        CHAR(2)        NOT NULL UNIQUE,
     name                VARCHAR(40)    NOT NULL,
     PRIMARY KEY(country_code)
);
```

functional dependencies

country_code → name

sample data

country_code	name
US	United States
UK	United Kingdom
CA	Canada
CN	China
AT	Austria
CL	Chile
CR	Costa Rica
DE	Germany
FJ	Fiji
ES	Spain
GH	Ghana
GR	Greece
MX	Mexico

airports table

Contains the list of airports the airline flies to and from. The primary key, ***iata_code***, is a unique 3-letter abbreviation for an airport that is assigned by the International Air Transport Association (IATA). Since, the code is unique, it serves as the primary key, rather than creating and using an automatically incremented integer column.

```
CREATE TABLE IF NOT EXISTS airports (
     iata_code      CHAR(3)        NOT NULL UNIQUE,
     airport_name        VARCHAR(40)    NOT NULL,
     country_code        CHAR(2)        NOT NULL,
     PRIMARY KEY (iata_code),
     FOREIGN KEY(country_code) REFERENCES countries(country_code)
);
```

functional dependencies

iata_code → airport_name, country_code

sample data

iata_code	airport_name	country_code
JFK	John F. Kennedy International Airport	US
EWR	Newark International Airport	US
HNL	Honolulu International Airport	US
DEN	Denver International Airport	US
LAX	Los Angeles International Airport	US
ORD	O’Hare International Airport	US
LHR	London Heathrow Airport	UK

routes table

This table contains a complete list of routes that the airline flies. A route is defined as a path with an origin airport and a destination airport. An auto-incremented primary key is needed because airline flight numbers are ***not*** unique. They are sometimes reused for different origin and/or destination airports.

```
CREATE TABLE IF NOT EXISTS routes (
     route_id                 SERIAL         NOT NULL UNIQUE,
     flight_num               SMALLINT       NOT NULL CHECK (flight_num > 0),
     origin_airport           CHAR(3)        NOT NULL,
     destination_airport      CHAR(3)        NOT NULL,
     aircraft_id              INTEGER        NOT NULL,
     distance_miles           SMALLINT       NOT NULL CHECK (distance_miles > 0),
     CONSTRAINT diff_orig_dest_airport CHECK(origin_airport != destination_airport),
     PRIMARY KEY (route_id),
     FOREIGN KEY (origin_airport)       REFERENCES airports(iata_code),
     FOREIGN KEY (destination_airport)  REFERENCES airports(iata_code)
);
```

functional dependencies

route_id → flight_num, origin_airport, destination_airport, aircraft_id, distance_miles

sample data

route_id	flight_num	origin_airport	destination_airport	aircraft_id	distance_miles
1	15	EWR	HNL	1	4962
2	14	HNL	EWR	1	4962
3	110	EWR	LHR	2	3466
4	535	JFK	LAX	1	2475
5	1293	LAX	JFK	1	2475
6	1025	HNL	LAX	1	2556
7	1742	LAX	ORD	2	1745
8	377	ORD	EWR	3	719
9	1671	DEN	LAX	4	862
10	383	HNL	DEN	2	3365

flight_statuses table

Contains the list of possible statuses for scheduled flights.

```
CREATE TABLE IF NOT EXISTS route_statuses (
     status_id           SERIAL         NOT NULL UNIQUE,
     name                VARCHAR(30)    NOT NULL,
     PRIMARY KEY (status_id)
);
```

functional dependencies

status_id → name

sample data

status_id	name
1	On Time
2	Delayed
3	Arrived
4	Scheduled

flights table

The list of all scheduled flights. A flight is defined as a route with a departure date and time. There cannot be a flight with the same route that departs on the same date and time. The base price (in USD) is the minimum cost for a single passenger traveling on the route. This price can vary depending on the time of year (i.e. February vs. Christmas Eve).

```
CREATE TABLE IF NOT EXISTS flights (
     route_id           INTEGER                  NOT NULL,
     depart_timestamp   TIMESTAMP WITH TIME ZONE NOT NULL,
     arrive_timestamp   TIMESTAMP WITH TIME ZONE NOT NULL,
     base_price_usd     MONEY                    NOT NULL CHECK (base_price_usd >  0.0::text::money),
     status_id          INTEGER                  NOT NULL,
     PRIMARY KEY (route_id, depart_timestamp),
     FOREIGN KEY (route_id)       REFERENCES routes(route_id),
     FOREIGN KEY (status_id)      REFERENCES route_statuses(status_id)
);
```

functional dependencies

route_id, depart_timestamp → arrive_timestamp, base_price_usd, status_id

sample data

route_id	depart_timestamp	arrive_timestamp	base_price_usd	status_id
1	2013-05-18 13:18:00-04	2013-05-18 23:23:00-04	525.36	4
1	2014-05-18 13:18:00-04	2013-05-18 23:23:00-04	525.36	4
2	2014-05-28 02:35:00-04	2013-05-28 11:40:00-04	851.49	1
6	2013-07-17 12:05:00-04	2013-07-17 17:36:00-04	970.67	4
10	2013-07-30 04:00:00-04	2013-07-30 10:53:00-04	756.94	1
5	2013-07-17 19:25:00-04	2013-07-18 01:15:00-04	491.29	4
6	2013-11-10 11:05:00-04	2013-07-17 17:36:00-04	689.24	4
7	2013-08-01 14:04:00-04	2013-08-01 18:00:00-04	567.71	4
3	2013-08-26 09:00:00-04	2013-07-30 03:53:00-04	1,124.65	4
10	2013-08-15 04:00:00-04	2013-08-15 10:53:00-04	925.95	4
8	2013-07-29 07:00:00-04	2013-07-29 09:05:00-04	289.73	4

itineraries table

The table containing the list of passenger itineraries. Many passengers can have the same itinerary. Many passengers can have many itineraries. Once an itinerary, (which may contain more than one flight), has been booked, the per person cost for the itinerary (not the flight) will be stored. This cost would be determined by the interfacing application, after taxes and fees have been included. When the total cost needs to be calculated, the cost can be multiplied by the number of passengers with the same itinerary number.

```
CREATE TABLE IF NOT EXISTS itineraries (
     itinerary_id            CHAR(6)   NOT NULL UNIQUE,
     per_person_price_usd    MONEY     NOT NULL CHECK (per_person_price_usd >  0.0::text::money),
     PRIMARY KEY (itinerary_id)
);
```

functional dependencies

<u>itinerary_id</u> → per_person_price_usd

sample data

itinerary_id	per_person_price_usd
BM87C0	1347.57
DZB665	350.89
MGEWFT	1187.12
WXPL21	689.67
AX9R3E	975.41
P4XBRR	734.72
KL2CA5	513.14

passengers_on_flights table

Contains information about which flight a passenger is on, their itinerary number, and the seat number that he or she is assigned. Since ***seat_num*** is not normalized and has no constraints, a trigger has been defined to address this issue as it is important that one seat not be assigned to multiple passengers on a scheduled flight.

```
CREATE TABLE IF NOT EXISTS passengers_on_flights (
     itinerary_id        INTEGER                  NOT NULL,
     route_id            INTEGER                  NOT NULL,
     depart_timestamp    TIMESTAMP WITH TIME ZONE NOT NULL,
     person_id           INTEGER                  NOT NULL,
     seat_num            CHAR(3)                  NOT NULL,
     PRIMARY KEY (itinerary_id, route_id, depart_timestamp, person_id),
     FOREIGN KEY (person_id) REFERENCES passengers(person_id)
);
```

functional dependencies

itinerary_id, route_id, depart_timestamp, person_id → seat_num

sample data

itinerary_id	route_id	depart_timestamp	person_id	seat_num
BM87C0	1	2013-05-18 13:18:00-04	1	1A
BM87C0	1	2013-05-18 13:18:00-04	2	1B
BM87C0	1	2013-05-18 13:18:00-04	3	1C
P4XBRR	2	2014-05-28 02:35:00-04	1	2A
P4XBRR	5	2013-07-17 19:25:00-04	1	2A
AX9R3E	3	2013-08-26 09:00:00-04	7	31B
AX9R3E	3	2013-08-26 09:00:00-04	8	11A
KL2CA5	10	2013-08-15 04:00:00-04	4	11B
KL2CA5	10	2013-08-15 04:00:00-04	5	11C
KL2CA5	10	2013-08-15 04:00:00-04	6	11D
KL2CA5	10	2013-08-15 04:00:00-04	1	10D

valid_flight_seat_trigger

```
CREATE OR REPLACE FUNCTION valid_flight_seat_trigger()
RETURNS trigger AS $$
DECLARE
	seat_count INTEGER := 0;
	seat_avail INTEGER := 0;
BEGIN
	-- Is seat number specified?
	IF NEW.seat_num IS NULL THEN
		RAISE EXCEPTION 'Invalid seat_num given';
	END IF;

	-- Is seat number valid for the aircraft flying this route?
	SELECT COUNT(s.seat_num)
	INTO seat_count
	FROM routes r
	INNER JOIN aircrafts a
		ON r.aircraft_id = a.aircraft_id
	INNER JOIN aircraft_seats s
		ON a.aircraft_id = s.aircraft_id
	WHERE r.route_id = NEW.route_id
	  AND s.seat_num = NEW.seat_num;

	IF (seat_count = 1) THEN

		-- Is seat number for the flight available?
		SELECT COUNT(seat_num)
		INTO seat_avail
		FROM passengers_on_flights
		WHERE route_id = NEW.route_id
		  AND depart_timestamp = NEW.depart_timestamp
		  AND seat_num = NEW.seat_num;
		IF (seat_avail != 0) THEN
			RAISE EXCEPTION 'Seat for this flight is occupied.';
		END IF;
	ELSE
		RAISE EXCEPTION 'Invalid seat number for this aircraft.';
	END IF;
```

(continues...)

In PostgreSQL, the main logic for triggers is contained in a stored procedure that is specified by the code: ***RETURNS trigger***. The procedure must then be specified in the ***CREATE TRIGGER*** statement. The trigger will be called every time an ***UPDATE*** or ***INSERT*** command is executed on the ***passenger_on_flights*** table. Then, the ***valid_flight_seat_trigger*** procedure will be executed. There are two validation steps before the data in the tables can be modified. First, the trigger needs to determine if the seat number exists on the aircraft that is flying this route. Then, it must determine if the seat is occupied by another passenger. If there is a conflict, an error occurs and the changes will not be comitted.

valid_flight_seat_trigger (continued)

```
      IF (TG_OP = 'INSERT') THEN
           INSERT INTO passengers_on_flights (itinerary_id, route_id, depart_timestamp, person_id, seat_num)
                VALUES (NEW.itinerary_id, NEW.route_id, NEW.depart_timestamp, NEW.person_id, NEW.seat_num);
           RAISE NOTICE 'Passenger was assigned to flight and seat successfully.';

      ELSIF (TG_OP = 'UPDATE') THEN
           UPDATE passengers_on_flights
              SET (itinerary_id, route_id, depart_timestamp, person_id, seat_num)
                = (NEW.itinerary_id, NEW.route_id, NEW.depart_timestamp, NEW.person_id, NEW.seat_num)
            WHERE itinerary_id = OLD.itinerary_id
              AND route_id = OLD.route_id
              AND depart_timestamp = OLD.depart_timestamp
              AND person_id = OLD.person_id;
            RAISE NOTICE 'Passenger seat assignment and/or flight updated successfully.';
      END IF;

RETURN NULL;
END;
$$ LANGUAGE plpgsql;

CREATE TRIGGER valid_flight_seat_trigger
      BEFORE INSERT OR UPDATE ON passengers_on_flights
      FOR EACH ROW
      WHEN (pg_trigger_depth() = 0)
      EXECUTE PROCEDURE valid_flight_seat_trigger();
```

Technical Note: ***pg_trigger_depth()*** is a PostgreSQL system information function that provides the current nesting level of the trigger. This is needed to prevent the *INSERT INTO* and *UPDATE* commands inside the trigger procedure from recursively activating the trigger, thus causing an infinite loop.

flight_duration

The duration of a flight is information that will need to be calculated frequently as it is useful to have on a passenger itinerary. The stored procedure allows the database to calculate the duration without forcing the interfacing application to calculate the value. At the same time, if the interfacing application wants to calculate the duration instead of the database, then ***depart_timestamp*** and ***arrive_timestamp*** can be selected from the ***flights*** table. The duration is calculated by subtracting the departure time stamp from the arrival time stamp.

```
CREATE OR REPLACE FUNCTION flight_duration(route_pk INTEGER, depart_ts_pk TIMESTAMP WITH TIME ZONE)
RETURNS TIME AS $$
DECLARE
     duration TIME WITHOUT TIME ZONE;
BEGIN
     SELECT (arrive_timestamp::TIMESTAMP WITH TIME ZONE  - depart_timestamp::TIMESTAMP WITH TIME ZONE)
     INTO duration
     FROM flights
     WHERE route_id = route_pk
       AND depart_timestamp = depart_ts_pk;
RETURN duration AS duration;
END;
$$ LANGUAGE plpgsql;
```

layover_time

Calculates the layover time between two flights. The layover time is when a passenger is not aboard an active flight and must wait for the next flight in his or her itinerary. The required parameters are the ***route_id*** and ***depart_timestamp*** for the first and second flight. The *TIMESTAMPTZ* is a synonym for the *TIME STAMP WITH TIME ZONE* data type. The arrival time for the first flight is subtracted from the departure time of the second flight.

```
CREATE OR REPLACE FUNCTION layover_time(route_1 INTEGER, depart_ts_1 TIMESTAMPTZ, route_2 INTEGER,
depart_ts_2 TIMESTAMPTZ)
RETURNS TIME AS $$
DECLARE
     arrive_time_1 TIMESTAMP WITH TIME ZONE;
     depart_time_2 TIMESTAMP WITH TIME ZONE;

BEGIN
     SELECT arrive_timestamp
     INTO arrive_time_1
     FROM flights
     WHERE route_id = route_1
       AND depart_timestamp = depart_ts_1;

     SELECT depart_timestamp
     INTO depart_time_2
     FROM flights
     WHERE route_id = route_2
       AND depart_timestamp = depart_ts_2;
RETURN (depart_time_2 - arrive_time_1);
END;
$$ LANGUAGE plpgsql;
```

flights_arrivals

Access to flight status information is absolutely necessary. This view could be used by airport systems that display information about flights. It could also be used by third parties, such as FlightAware—a flight tracking and status website.

```
CREATE VIEW flights_arrivals AS
     SELECT f.depart_timestamp,
            f.arrive_timestamp,
            r.flight_num,
            r.origin_airport,
            r.destination_airport
     FROM flights f
     INNER JOIN routes r
          ON f.route_id = r.route_id
     INNER JOIN airports a
          ON r.origin_airport = a.iata_code
            AND r.destination_airport = a.iata_code;
```

use example

```
SELECT *
FROM flights_arrivals
WHERE destination_airport = 'EWR'
ORDER BY arrive_timestamp DESC
LIMIT 20;
```

In the above example, arrival information can be narrowed down to show only those flights arriving at the airport the information screen is located. In addition, the list can be sorted in descending order, with the latest arrivals at the top of the result set. Since only so many rows can be displayed on the screen at once, the results can be reduced to the latest 20 flights.

passenger manifest for a scheduled flight

This report is useful for gate agents and flight attendants to be able print a physical copy of the list of passengers on the flight. Airlines are required to have a manifest on board the flight. Should a problem or unfortunate event occur, the crew will be able to identify and account for all on board passengers.

```
SELECT pers.first_name,
       pers.middle_name,
       pers.last_name,
       pers.gender,
       pf.seat_num
FROM passengers_on_flights pf
INNER JOIN passengers pass
     ON pf.person_id = pass.person_id
INNER JOIN persons pers
     ON pass.person_id = pers.person_id
WHERE route_id = '----'
  AND depart_timestamp = '---'
ORDER BY pers.last_name ASC;
```

use example

```
SELECT pers.first_name,
       pers.middle_name,
       pers.last_name,
       pers.gender,
       pf.seat_num
FROM passengers_on_flights pf
INNER JOIN passengers pass
     ON pf.person_id = pass.person_id
INNER JOIN persons pers
     ON pass.person_id = pers.person_id
WHERE route_id = '6'
  AND depart_timestamp = '2013-07-17 12:05:00-04'
ORDER BY pers.last_name ASC;
```

passengers with a TSA redress number

This report allows the airline to retrieve all individuals who are have a TSA redress number. It may be necessary for the airline to provide a list of these people for TSA security officers . Also, it should able to quickly identify these individuals for security reasons, should the airline be involved in a federal investigation.

```
SELECT pers.first_name,
       pers.middle_name,
       pers.last_name,
       pers.date_of_birth,
       pers.gender,
       pers.phone_primary,
       pass.tsa_redress_num
FROM passengers pass
INNER JOIN persons pers
     ON pass.person_id = pers.person_id
WHERE tsa_redress_num != '';
```

a single itinerary

For functions related to searching for a flight, that is an individual who is a potential passenger of a flight, the application should interact with the database with the ***flight_search*** user. This user has read-only functionality on the appropriate tables. When, the user decides to book a flight, the application will then use the ***flight_book*** user (next page).

```
SELECT pers.first_name,
       pers.middle_name,
       pers.last_name,
       f.depart_timestamp,
       f.arrive_timestamp,
       r.origin_airport,
       r.destination_airport,
       r.distance_miles,
       a.manufacturer,
       a.model,
       flight_duration(f.route_id, f.depart_timestamp)
FROM passengers_on_flights pf
INNER JOIN passengers pass
     ON pf.person_id = pass.person_id
INNER JOIN persons pers
     ON pass.person_id = pers.person_id
INNER JOIN flights f
     ON pf.route_id = f.route_id
       AND pf.depart_timestamp = f.depart_timestamp
INNER JOIN routes r
     ON f.route_id = r.route_id
INNER JOIN aircrafts a
     ON r.aircraft_id = a.aircraft_id
WHERE pf.itinerary_id = 'BM87C0';
```

flight_search role

For functions related to searching for a flight, that is an individual who is a potential passenger of a flight, the application should interact with the database with the ***flight_search*** user. This user has read-only functionality on the appropriate tables. When, the user decides to book a flight, the application will then use the ***flight_book*** user (next page).

```
REVOKE ALL PRIVILEGES ON employees FROM flight_search;
REVOKE ALL PRIVILEGES ON persons FROM flight_search;
REVOKE ALL PRIVILEGES ON passengers FROM flight_search;
REVOKE ALL PRIVILEGES ON itineraries FROM flight_search;
REVOKE ALL PRIVILEGES ON flights FROM flight_search;
REVOKE ALL PRIVILEGES ON route_statuses FROM flight_search;
REVOKE ALL PRIVILEGES ON routes FROM flight_search;
REVOKE ALL PRIVILEGES ON passengers_on_flights FROM flight_search;
REVOKE ALL PRIVILEGES ON countries FROM flight_search;
REVOKE ALL PRIVILEGES ON airports FROM flight_search;
REVOKE ALL PRIVILEGES ON aircrafts FROM flight_search;
REVOKE ALL PRIVILEGES ON aircraft_seats FROM flight_search;
REVOKE ALL PRIVILEGES ON seat_classes FROM flight_search;

GRANT SELECT ON flights FROM flight_search;
GRANT SELECT ON route_statuses FROM flight_search;
GRANT SELECT ON routes FROM flight_search;
GRANT SELECT ON passengers_on_flights FROM flight_search;
GRANT SELECT ON countries FROM flight_search;
GRANT SELECT ON airports FROM flight_search;
GRANT SELECT ON aircrafts FROM flight_search;
GRANT SELECT ON aircraft_seats FROM flight_search;
GRANT SELECT ON seat_classes FROM flight_search;
```

flight_book role

Once an individual decides to complete the purchase of his or her itinerary, the application should use the ***flight_book*** user that allows the potential passenger to book a flight and be classified as a passenger. When the user decides to book a flight, then he or she should be granted permission to insert new rows of data into the appropriate tables.

```
REVOKE ALL PRIVILEGES ON employees FROM flight_book;
REVOKE ALL PRIVILEGES ON persons FROM flight_book;
REVOKE ALL PRIVILEGES ON passengers FROM flight_book;
REVOKE ALL PRIVILEGES ON itineraries FROM flight_book;
REVOKE ALL PRIVILEGES ON flights FROM flight_book;
REVOKE ALL PRIVILEGES ON route_statuses FROM flight_book;
REVOKE ALL PRIVILEGES ON routes FROM flight_book;
REVOKE ALL PRIVILEGES ON passengers_on_flights FROM flight_book;
REVOKE ALL PRIVILEGES ON countries FROM flight_book;
REVOKE ALL PRIVILEGES ON airports FROM flight_book;
REVOKE ALL PRIVILEGES ON aircrafts FROM flight_book;
REVOKE ALL PRIVILEGES ON aircraft_seats FROM flight_book;
REVOKE ALL PRIVILEGES ON seat_classes FROM flight_book;

GRANT INSERT, SELECT ON persons FROM flight_book;
GRANT INSERT, SELECT ON passengers FROM flight_book;
GRANT SELECT ON flights FROM flight_book;
GRANT SELECT ON route_statuses FROM flight_book;
GRANT SELECT ON routes FROM flight_book;
GRANT INSERT, SELECT ON passengers_on_flights FROM flight_book;
GRANT INSERT, SELECT ON itineraries FROM flight_book;
GRANT SELECT ON countries FROM flight_book;
GRANT SELECT ON airports FROM flight_book;
GRANT SELECT ON aircrafts FROM flight_book;
GRANT SELECT ON aircraft_seats FROM flight_book;
GRANT SELECT ON seat_classes FROM flight_book;
```

passenger role

A passenger is a person (employee or non-employee) with a valid itinerary. After the individual becomes a passenger, the application should use this user role. This user also permits returning/loyal passengers with user accounts (not part of this database design) to edit information that may change over time. For example, name, phone number and email. For the tables in this design, the passenger should be allowed to only update rows of data, not insert new rows.

```
REVOKE ALL PRIVILEGES ON employees FROM passenger;
REVOKE ALL PRIVILEGES ON persons FROM passenger;
REVOKE ALL PRIVILEGES ON passengers FROM passenger;
REVOKE ALL PRIVILEGES ON itineraries FROM passenger;
REVOKE ALL PRIVILEGES ON flights FROM passenger;
REVOKE ALL PRIVILEGES ON route_statuses FROM passenger;
REVOKE ALL PRIVILEGES ON routes FROM passenger;
REVOKE ALL PRIVILEGES ON passengers_on_flights FROM passenger;
REVOKE ALL PRIVILEGES ON countries FROM passenger;
REVOKE ALL PRIVILEGES ON airports FROM passenger;
REVOKE ALL PRIVILEGES ON aircrafts FROM passenger;
REVOKE ALL PRIVILEGES ON aircraft_seats FROM passenger;
REVOKE ALL PRIVILEGES ON seat_classes FROM passenger;

GRANT SELECT, UPDATE ON persons FROM passenger;
GRANT SELECT, UPDATE ON passengers FROM passenger;
GRANT SELECT, UPDATE ON itineraries FROM passenger;
GRANT SELECT ON flights FROM passenger;
GRANT SELECT ON route_statuses FROM passenger;
GRANT SELECT ON routes FROM passenger;
GRANT SELECT ON passengers_on_flights FROM passenger;
GRANT SELECT ON countries FROM passenger;
GRANT SELECT ON airports FROM passenger;
GRANT SELECT ON aircrafts FROM passenger;
GRANT SELECT ON aircraft_seats FROM passenger;
GRANT SELECT ON seat_classes FROM passenger;
```

ticket_agent role

This user role is for applications that allow employees to check in customers when they arrive. Ticket agents should be allowed to update customer data, such as name, traveler numbers and seat assignments. In addition, they should be able to book flights for customers in the event of delayed, canceled or missed flights. They have access to all tables except for the ***employees*** table.

```
REVOKE ALL PRIVILEGES ON employees FROM ticket_agent;
REVOKE ALL PRIVILEGES ON persons FROM ticket_agent;
REVOKE ALL PRIVILEGES ON passengers FROM ticket_agent;
REVOKE ALL PRIVILEGES ON itineraries FROM ticket_agent;
REVOKE ALL PRIVILEGES ON flights FROM ticket_agent;
REVOKE ALL PRIVILEGES ON route_statuses FROM ticket_agent;
REVOKE ALL PRIVILEGES ON routes FROM ticket_agent;
REVOKE ALL PRIVILEGES ON passengers_on_flights FROM ticket_agent;
REVOKE ALL PRIVILEGES ON countries FROM ticket_agent;
REVOKE ALL PRIVILEGES ON airports FROM ticket_agent;
REVOKE ALL PRIVILEGES ON aircrafts FROM ticket_agent;
REVOKE ALL PRIVILEGES ON aircraft_seats FROM ticket_agent;
REVOKE ALL PRIVILEGES ON seat_classes FROM ticket_agent;

GRANT UPDATE, INSERT, SELECT ON persons FROM ticket_agent;
GRANT UPDATE, INSERT, SELECT ON passengers FROM ticket_agent;
GRANT UPDATE, INSERT, SELECT ON itineraries FROM ticket_agent;
GRANT SELECT ON flights FROM ticket_agent;
GRANT SELECT ON route_statuses FROM ticket_agent;
GRANT SELECT ON routes FROM ticket_agent;
GRANT UPDATE, INSERT, SELECT ON passengers_on_flights FROM ticket_agent;
GRANT SELECT ON countries FROM ticket_agent;
GRANT SELECT ON airports FROM ticket_agent;
GRANT SELECT ON aircrafts FROM ticket_agent;
GRANT SELECT ON aircraft_seats FROM ticket_agent;
GRANT SELECT ON seat_classes FROM ticket_agent;
```

implementation notes

- The interfacing software is expected to dynamically calculate
  - Appropriate connecting flights (i.e. two flights that do not overlap in time)
- Time zones
  - In the case of an ***INSERT***: The server is expected to convert timestamps to the server's time zone.
  - The server stores time zones in UTC (Universal Coordinated Time), also known as GMT (Greenwich Mean Time).
- Airlines always change prices of flights according to demand/popularity, availability, date, time, etc.
  - The interfacing application is expected to calculate pricing that incorporates the mentioned factors. The database simply stores the base (or minimum) price of a single flight.
- TSA (Transportation Security Administration)
  - The ***Secure Flight Passenger Data Definitions*** document (version 1.0) provides guidelines on the different pieces of data to help companies in the airlines industry design their systems.
  - They recommend the length of the Redress Number be 13 characters
  - They recommend the length of the Known Traveler Number be 25 characters.
  - These numbers are assigned by the Department of Homeland Security (DHS)
  - Document link: http://www.tsa.gov/sites/default/files/assets/pdf/secure_flight_passenger_data_definitions.pdf

known problems

- What happens when flights have been completed?
  - The data should be transfered to a historical flight records table
- Generation of unique itinerary numbers is not implemented by the database
- Create more user roles, as the airline industry has more roles
- More views should be created and used to interface with applications, to protect the underlying implementation and data.

future enhancements

- Add support for
  - Groups of flights for a single itinerary. For example, itineraries that have multiple destinations (or multiple sets of flights). Passengers should be allowed to book a multiple destination itinerary. A passenger might want to fly from Los Angeles to Denver on October 1st, then on October 9th, fly from Denver to New York. Then, on October 18th, fly from New York back to Los Angeles. With the current database design, this cannot be done by sorting all the flights according to departure time in ascending order. The system cannot determine which individual flight (leg) belongs to which group of flights.

  - Frequent flyer program (United MileagePlus®)

  - Special baggage (i.e. surfboards, live animals)

  - Codeshare flights (when two or more airlines share the same flight). This would require another table with a list of airlines, their unique carrier code (United's code is UA).