CSU 44D01

Information Management

Trinity College Dublin

Submitted by

Apnatva Singh Rawat

21354929

Contents

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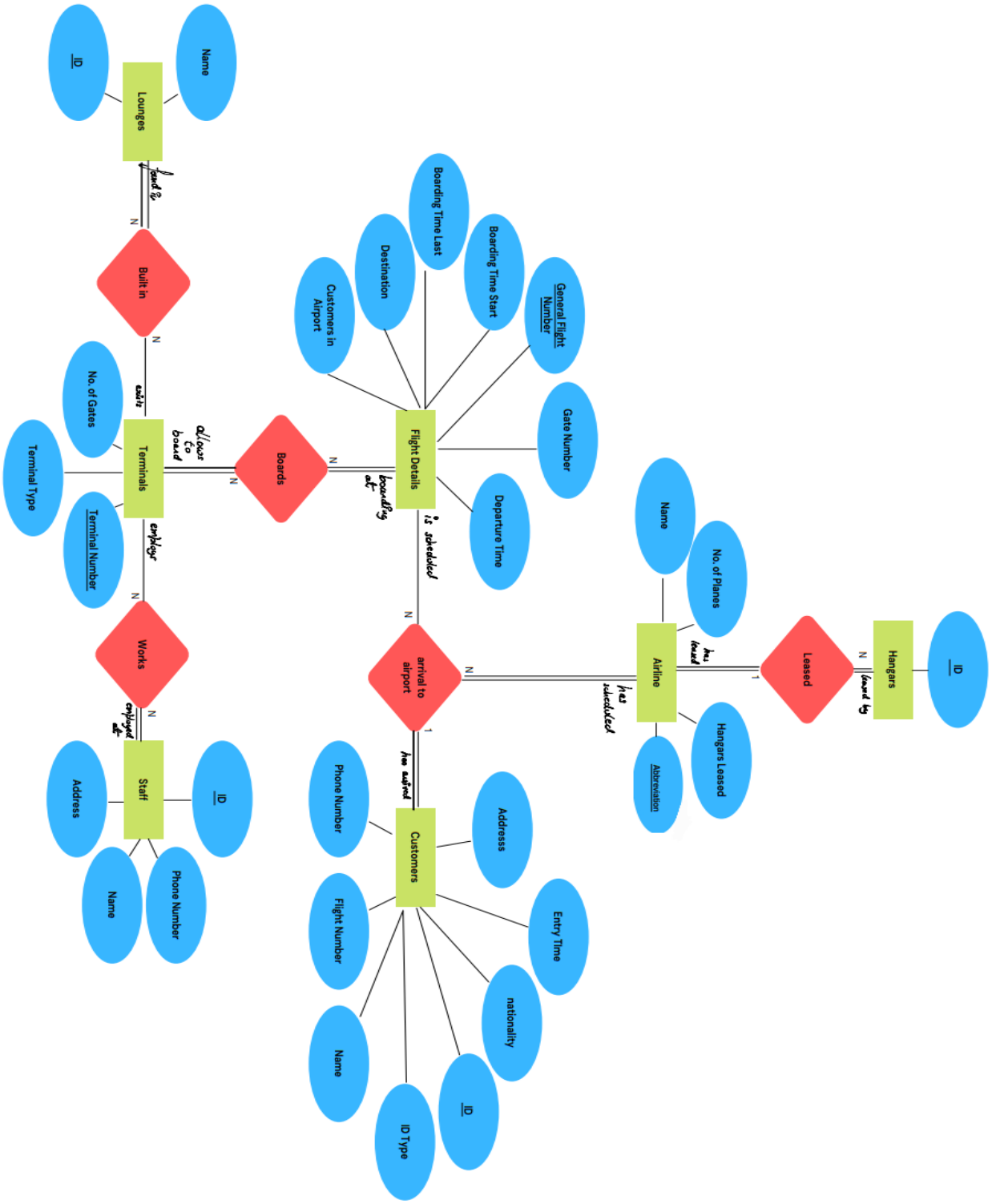
Information Management

This project aims to model the database of an airport. The tables hold information regarding Airlines, their Flight Plans, Number of Planes that can be intersected with the data on Customers to provide them with personalized data which is easy to retrieve. It also contains information about the staff employed by the airport. To limit the size of the database, I chose to ignore the presence of shops, and restaurants, but I did include lounges. The entries in each table are also limited, which is unrealistic, but such huge data can only be operated by some level of automation which I cannot achieve and is out of the scope of this project. Apart from these, the database has been designed to be as realistic as possible. Another additional note is that the database only takes into account outbound flights.

The tables in the database include a terminal, airline, flight_details, customers, lounges, secondary_flight_details, hangars, staff, and staff_terminal. Table names are very generic and model as their name suggests. Some of the tables are present only to model one-to-many or many-to-many relationships in the database.

The tables were normalized with BCN leading to extra tables to represent the many-to-one relationships. All attributes in the table are directly and only dependent on the full primary key of the table.

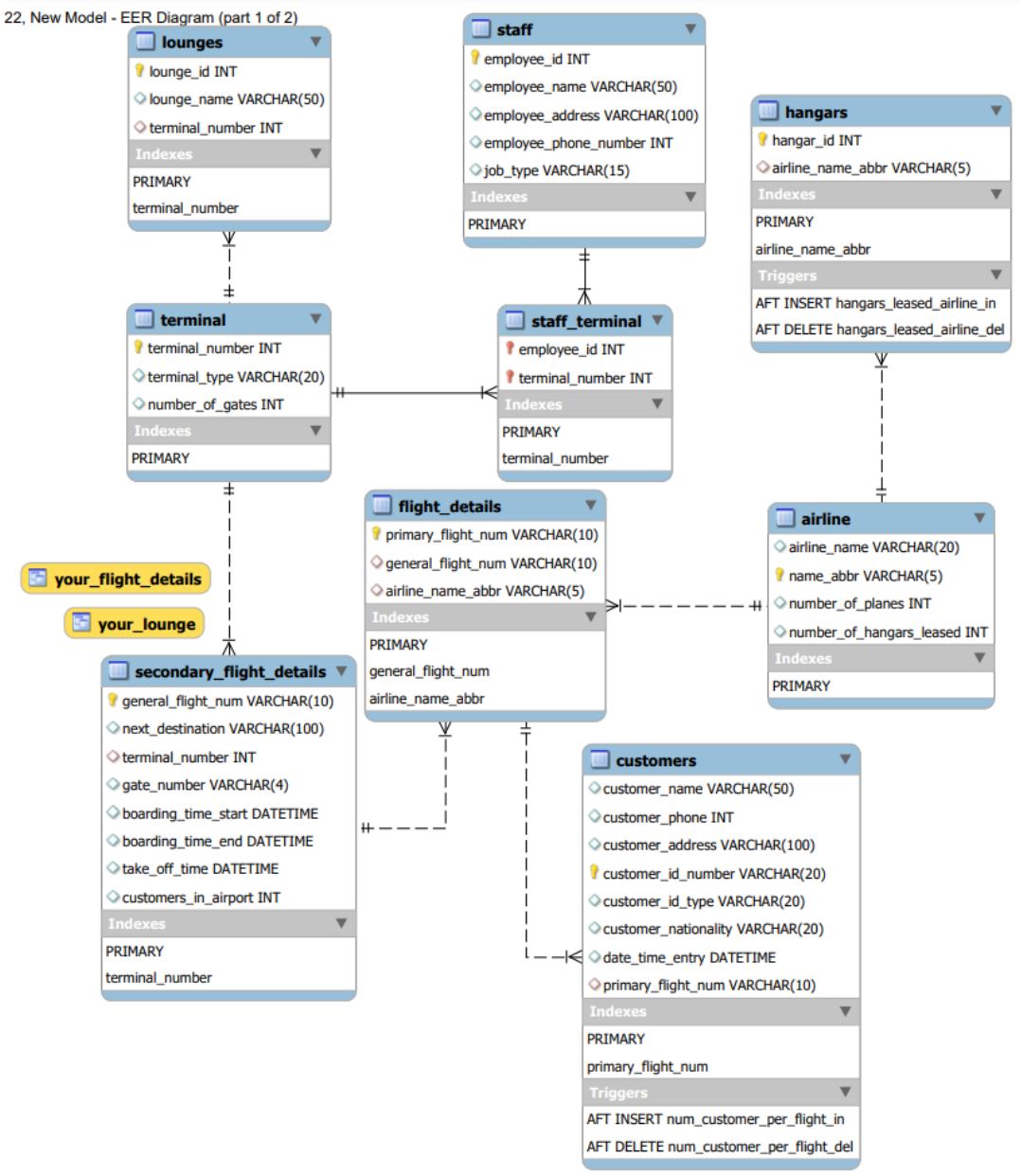
Entity Relationship Diagram



Mapping to Relational Schema

Functional Dependency Diagrams

From MySQL Workbench



Explanations and SQL Codes

Creating and Using the Database

```
-- create database
create database flight;
-- use this database
use flight;
```

Creating the Database Tables

1. Creating a table to model terminals. Each terminal is assigned a unique number which acts as an identifier. It describes the number of gates in the terminal and the type, Domestic, International, or Cargo.

```
create table terminal(
    terminal_number int,
    terminal_type varchar(20) not null,
    number_of_gates int,
    primary key (terminal_number)
    );
```

2. Creating a table to model the airlines. Each airline is assumed to have a unique name. An abbreviation is also associated with the airline which is used as the primary key since that would always be of a constant length which makes it easier when using it as a foreign key. It contains information regarding the number of planes the airline currently has in the airport and the number of hangars they have leased from the airport authorities.

```
create table airline(
    airline_name varchar(20) not null unique,
    name_abbr varchar(5),
    number_of_planes int,
    number_of_hangars_leased int default 0,
    primary key (name_abbr)
    );
```

3. A randomly generated alphanumeric code is assigned to each flight. This is stored as the general_flight_num which is used to uniquely identify each identity. The

information regarding a flight, the destination, where to board it from, what time to board it, and the take-off time is stored in this table.

```
create table secondary_flight_details(
    general_flight_num varchar(10),
    next_destination varchar(100),
    terminal_number int,
    gate_number varchar(4),
    boarding_time_start datetime,
    boarding_time_end datetime,
    take_off_time datetime,
    customers_in_airport int default 0,
    primary key (general_flight_num),
    foreign key (terminal_number) references terminal(terminal_number)
    );
```

4. This table maps the flight numbers (primary_flight_num) to the internal flight numbers general_flight_num (reference table secondary_flight_details). Multiple airlines can run the same flight making this table necessary. It also references the name_abbr (table airline) to identify which airline has scheduled the flight. The on-delete cascade allows the database to take the information of the flight once it has taken off. According to the rules of mapping, the general flight number should have been stored in the column for customers as it is a many-to-one relationship. But this number is for internal use by the airport, and hence should not be available to a customer. This was why a new table was constructed to accurately map all the foreign keys.

```
create table flight_details(
    primary_flight_num varchar(10),
    general_flight_num varchar(10),
    airline_name_abbr varchar(5),
    primary key (primary_flight_num),
    foreign key (general_flight_num) references
secondary_flight_details(general_flight_num) on delete cascade,
    foreign key (airline_name_abbr) references airline(name_abbr)
    );
```

5. This table stores information about all the customers who have entered the airport. Since customers can enter the airport with various valid IDs (Passports, National-ID) so a customer_id_type had to be included where the customer_id_num is the primary key for the table. Other information like name, phone number, address, time of entry, and flight number is stored in the table. The ON DELETE CASCADE constraint allows all customers to be removed from the database for the flight that has taken off.

```
create table customers(
    customer_name varchar(50),
    customer_phone int,
    customer_address varchar(100),
    customer_id_number varchar(20),
    customer_id_type varchar(20),
    customer_nationality varchar(20),
    date_time_entry datetime,
    primary_flight_num varchar(10),
    primary key (customer_id_number),
    foreign key (primary_flight_num) references
flight_details(primary_flight_num) on delete cascade
    );
```

6. Contains information about lounges which can be uniquely identified by a lounge_id (primary key). A lounge is available to every customer in that terminal and hence references the terminal_number from the table terminal. The secondary identification of a lounge is its name, which is less generic than just calling the lounge by a number.

```
create table lounges(
    lounge_id int,
    lounge_name varchar(50) default 'Lounge',
    terminal_number int,
    primary key (lounge_id),
    foreign key (terminal_number) references terminal(terminal_number)
    );
```

7. Planes are parked in the hangar, where each hangar has a unique ID assigned to it as hangar_id (primary key). It references the airline table as airline_name_abbr so that

we can associate an airline with it. This is helpful for airlines to identify if they need to lease more hangars or less by presenting a count of hangars for their airline.

```
create table hangars(
    hangar_id int,
    airline_name_abbr varchar(5),
    primary key (hangar_id),
    foreign key (airline_name_abbr) references airline(name_abbr)
    );
```

8. This table stores information about the staff that is employed by the airport only. It does not include information about pilots, co-pilots, stewards, etc. who work for an airline. It focuses on staff which is concerned with the cleanliness, and security, of the airport, managing flight and landing schedules, and runway. Some information to identify the staff is stored, employee_id (primary key) their name, address, phone number, and job_type which describes cleaning, security, etc.

```
create table staff(
    employee_id int,
    employee_name varchar(50),
    employee_address varchar(100),
    employee_phone_number int,
    job_type varchar(15),
    primary key (employee_id)
    );
```

9. A staff can work at multiple terminals, this table stores information about how many and which terminals a staff member works in, referencing two tables staff and terminal. The two attributes are joined to form the primary key of the table.

```
create table staff_terminal(
    employee_id int,
    terminal_number int,
    foreign key (employee_id) references staff(employee_id),
    foreign key (terminal_number) references terminal(terminal_number),
    primary key (employee_id, terminal_number)
    );
```

Altering Tables

The following changes to the table are not intended in the final database. These queries were constructed to provide examples of how tables, columns, names, datatypes can be manipulated. The actual final database where the other queries are performed require that these changes (if made) are reversed.

1. Adding a new column(s)

```
alter table hangars
    add hangar_name varchar (20);
alter table staff
    add national_id_number varchar (10),
    add national_id_type varchar (10);
```

2. Changing the datatype of the column

```
alter table terminal
    modify column terminal_type int;
```

3. Renaming a column

```
alter table secondary_flight_info
    rename to more_flight_info;
```

Triggering Operations

1. Trigger to count the number of customers in each flight and update it in the secondary_flight_details table. Updates when new customers enter.

```
delimiter //
create trigger num_customer_per_flight_in
after insert on customers
for each row
begin
    declare new_count int;
    declare new_gen_flight_num varchar(10);
    set new_gen_flight_num = ( select flight_details.general_flight_num
from customers
                            left join flight_details
                            on  customers.primary_flight_num =
flight_details.primary_flight_num
                            where flight_details.primary_flight_num =
new.primary_flight_num
                            limit 1
                            );
    set new_count = ( select count(*) from customers
                    left join flight_details
                    on  customers.primary_flight_num =
flight_details.primary_flight_num
                    where flight_details.general_flight_num =
new_gen_flight_num
                    );
    update secondary_flight_details
        set customers_in_airport = new_count
        where new_gen_flight_num =
secondary_flight_details.general_flight_num;
end //
delimiter ;
```

2. Trigger to count the number of customers in each flight and update it in the secondary_flight_details table. Updates when a customer leaves.

```
delimiter //
create trigger num_customer_per_flight_del
after delete on customers
for each row
begin
    declare new_count int;
    declare old_gen_flight_num varchar(10);
    set old_gen_flight_num = ( select flight_details.general_flight_num
from customers
                            left join flight_details
                            on  customers.primary_flight_num =
flight_details.primary_flight_num
                            where flight_details.primary_flight_num =
old.primary_flight_num
                            limit 1
                            );
    set new_count = ( select count(*) from customers
                    left join flight_details
                    on  customers.primary_flight_num =
flight_details.primary_flight_num
                    where flight_details.general_flight_num =
old_gen_flight_num
                    );
    update secondary_flight_details
        set customers_in_airport = new_count
        where old_gen_flight_num =
secondary_flight_details.general_flight_num;
end //
delimiter ;
```

3. Counts the number of hangars leased by each airline when new entries are added into the hangars table.

```
delimiter //
create trigger hangars_leased_airline_in
after insert on hangars
for each row
begin
    declare new_count int;
    set new_count = ( select count(*) from hangars
                left join airline
                on hangars.airline_name_abbr = airline.name_abbr
                where airline.name_abbr = new.airline_name_abbr
                limit 1
                );
    update airline
        set number_of_hangars_leased = new_count
        where name_abbr = new.airline_name_abbr;
end //
delimiter ;
```

4. Counts the number of hangars leased by each airline when entries are removed from the hangars table.

```
delimiter //
create trigger hangars_leased_airline_del
after delete on hangars
for each row
begin
    declare new_count int;
    set new_count = ( select count(*) from hangars
                left join airline
                on hangars.airline_name_abbr = airline.name_abbr
                where airline.name_abbr = old.airline_name_abbr
                limit 1
                );
    update airline
        set number_of_hangars_leased = new_count
        where name_abbr = old.airline_name_abbr;
end //
delimiter ;
```

Creating Views

1. This will display all the details that a customer might require about their flight. It joins 4 tables, customers, airline, flight_details, and secondary_flight_details to get the desired result. This information constantly keeps updating because there might be delays on the flight.

```
create or replace view your_flight_details as (
    select customers.customer_name,
    customers.primary_flight_num,
    customers.customer_id_number,
    airline.airline_name,
    secondary_flight_details.terminal_number,
    secondary_flight_details.gate_number,
    secondary_flight_details.boarding_time_start,
    secondary_flight_details.boarding_time_end,
    secondary_flight_details.take_off_time
    from customers left join flight_details
    on customers.primary_flight_num = flight_details.primary_flight_num
    left join secondary_flight_details on
    flight_details.general_flight_num =
secondary_flight_details.general_flight_num
    left join airline on
    airline.name_abbr = flight_details.airline_name_abbr
);
```

2. Similar to the earlier view, this joins multiple tables to tell the customer the name of the lounge for the terminal they can go to. This is intended to be information that updates once for the customer and stays the same until the flight time. Due to the difference in the frequency required to access this information, they were kept in separate views.

```
create or replace view your_lounge as (
    select customers.customer_name,
    customers.primary_flight_num,
    customers.customer_id_number,
    secondary_flight_details.terminal_number,
    lounges.lounge_name
    from customers left join flight_details
    on customers.primary_flight_num = flight_details.primary_flight_num
    left join secondary_flight_details on
    flight_details.general_flight_num =
secondary_flight_details.general_flight_num
    left join lounges on
    secondary_flight_details.terminal_number = lounges.terminal_number
    );
```

Populating the Tables

1. Inserting values into the table terminal. 5 Entries.

```
insert into terminal values
    (1, "domestic", 10),
    (2, "domestic", 40),
    (3, "cargo", 20),
    (4, "international", 20),
    (5, "international", 30);
```

2. Inserting values into table airline. 5 Entries.

```
insert into airline (airline_name, name_abbr, number_of_planes)
    values ("Qatar Airways", "QAR", 19),
    ("Air India", "AIR", 23),
    ("Aer Lingus", "AEL", 45),
    ("Lufthansa", "LUF", 23),
    ("British Airways", "BRA", 38);
```

3. Inserting values into table secondary_flight_details. Default value for 0 customers is assigned automatically. 5 Entries.

```
insert into secondary_flight_details (
    general_flight_num,
    next_destination,
    terminal_number,
    gate_number,
    boarding_time_start,
    boarding_time_end,
    take_off_time) values
    ('random1', 'Bellavista', '1', 'H45', '2022-07-22 15:02:55', '2022-07-
08 15:58:28', '2022-07-22 16:33:41'),
    ('random2', 'Pontal', '4', 'J19', '2022-07-22 09:27:28', '2022-07-22
10:25:03', '2022-07-22 11:10:03'),
    ('random3', 'Huatajata', '1', 'L44', '2022-07-22 23:57:10', '2022-07-
23 00:50:29', '2022-07-23 01:22:06'),
    ('random4', 'Agualote', '2', 'S32', '2022-07-22 11:11:29', '2022-07-22
12:01:43', '2022-07-22 13:01:30'),
    ('random5', 'Ambatofinandrahana', '5', 'B29', '2022-07-22 19:39:31',
'2022-09-08 20:24:28', '2022-07-22 21:05:48');
```

4. Inserting values into table flight_details. 6 Entries.

```
insert into flight_details values
    ( 'QAR769', 'random1', 'QAR'), ( 'AIR802', 'random1', 'AIR'),
    ( 'AIR994', 'random2', 'AIR'), ( 'LUF676', 'random4', 'LUF'),
```

```
    ( 'AEL785', 'random3', 'AEL'), ( 'BRA426', 'random5', 'BRA');
```

5. Inserting values into table customers. 20 Entries.

```
insert into customers values
    ('Ned Nacey', '56850944', '58893 Bultman Way', '3CY2EWT8P',
'Passport', 'Poland', '2022-01-06 03:46:05', 'QAR769'),
    ('Granville Beaston', '11726708', '63 Stephen Plaza', 'VH5YSYL6E',
'Passport', 'Poland', '2022-10-25 11:17:44', 'AIR802'),
    ('Annice Klasen', '33619098', '955 Johnson Drive', 'YJJSBV0QH',
'Passport', 'Indonesia', '2022-08-24 20:18:54', 'AIR994'),
    ('Aldric Guite', '77370950', '63 Sheridan Trail', 'H3L25C1EJ',
'Passport', 'Madagascar', '2022-07-26 16:48:48', 'QAR769'),
    ('Helli Cardenas', '36375814', '58 Scoville Hill', '8JA4FDUEU',
'Passport', 'Argentina', '2022-04-23 20:06:00', 'AIR802'),
    ('Tory Dimbylow', '60507239', '37 Redwing Park', '0ZZODVWMJ',
'Passport', 'China', '2021-12-23 04:20:20', 'LUF676'),
    ('Briant McGookin', '28296325', '589 Armistice Parkway', 'Q88XXJ8TN',
'Passport', 'Czech Republic', '2022-04-25 21:32:46', 'AEL785'),
    ('Tiena Villaret', '84109979', '94740 Pearson Crossing', 'US5Y2DNTU',
'Passport', 'Vietnam', '2022-01-11 00:14:36', 'QAR769'),
    ('Carlye Fraine', '47873101', '97 Waywood Pass', '0272SXZT7',
'National-ID', 'South Africa', '2022-04-14 22:52:59', 'AEL785'),
    ('Emera Pomeroy', '82108194', '4 North Avenue', 'C6I7G9AJT',
'National-ID', 'Portugal', '2022-05-22 21:13:15', 'LUF676'),
    ('Roxane West-Frimley', '53083462', '87861 Boyd Center', 'GE8B6H2WL',
"Driver's Licence", 'Indonesia', '2022-04-07 13:10:35', 'AEL785'),
    ('Ora Wantling', '85293408', '09 Elka Center', 'NEV61CVOB', 'National-
ID', 'Brazil', '2021-12-29 11:21:50', 'QAR769'),
    ('Devin Caley', '94142481', '4 Hermina Hill', 'CC3J9Z086', 'National-
ID', 'Zimbabwe', '2022-06-07 22:07:55', 'LUF676'),
    ('Larina Deane', '87912508', '630 Pepper Wood Drive', 'IEPN7SEZF',
'Passport', 'Poland', '2022-06-02 08:02:22', 'LUF676'),
    ('Maurie Weins', '73989544', '75 Sauthoff Alley', 'MWFF74EXV',
'Passport', 'Yemen', '2022-10-14 22:19:25', 'QAR769'),
    ('Agnes Bogue', '80004987', '5 Talmadge Place', '5XISDRPTU',
'Passport', 'Argentina', '2021-11-23 16:44:12', 'BRA426'),
    ('Jaimie Rabat', '19943769', '32989 Dwight Alley', 'TCS3P85S0',
'Passport', 'Brazil', '2022-10-10 08:34:18', 'AEL785'),
    ('Bert Gerger', '89764303', '75 Oak Point', '5V5XTDSED', 'Passport',
'Indonesia', '2022-04-14 02:42:15', 'BRA426'),
    ('Debbie Baskeyfied', '50486105', '20 Village Green Hill',
'CSOAWY137', 'Passport', 'Brazil', '2022-02-20 04:18:08', 'BRA426'),
    ('Bryant Cramond', '93811915', '032 Graedel Circle', '1KNB6J7KJ',
'Passport', 'Indonesia', '2022-05-26 14:35:53', 'AIR802');
```

6. Inserting values into table lounges. 5 Entries.

```
insert into lounges values
    ( 1, "Main Lounge", 5),
    ( 2, "Side Lounge", 4),
    ( 3, "Side Lounge", 3),
    ( 4, "Small Lounge", 2),
    ( 5, "Crystal Lounge", 1),
    ( 6, "Mini Crystal Lounge", 1);
```

7. Inserting values into table hangars. 9 Entries.

```
insert into hangars values
    ( 1, "QAR"), ( 2, "QAR"), ( 3, "AIR"),
    ( 4, "BRA"), ( 5, "BRA"), ( 6, "BRA"),
    ( 7, "LUF"), ( 8, "AIR"), ( 9, "QAR");
```

8. Inserting values into table staff. 9 Entries.

```
insert into staff values
    (23, "Neil", "USA", 12345678, "Cleaning"),
    (24, "Patrick", "Ireland", 87654321, "Cleaning"),
    (12, "Harris", "UK", 345678934, "Security"),
    (56, "Chris", "France", 987643456, "Security"),
    (78, "Robert", "Spain", 456654219, "Control Tower"),
    (34, "Scarlett", "Germany", 987465768, "Cleaning"),
    (55, "Benedict", "221 B Baker Street", 876545678, "Help Desk"),
    (99, "Brie", "Canada", 345654321, "Control Tower"),
    (67, "Groot", "Dehradun", 789876545, "Security");
```

9. Inserting values into table staff_terminal. 15 Entries.

```
insert into staff_terminal values
    (23,1), (24,2), (12,3), (56,2), (78,2),
    (34,3), (55,4), (99,5), (67,3), (67,4),
    (56,5), (23,5), (23,4), (23,2), (34,1);
```

Retrieving Information from the Database

1. Selecting all columns from various tables in the database

```
select * from terminal;
select * from lounges;
select * from hangars;
select * from airline;
select * from staff;
select * from staff_terminal;
select * from secondary_flight_details;
```

2. Selecting all columns from various views in the database

```
select * from your_flight_details;
select * from your_lounge;
```

3. Returns the total number of gates in the airport.

```
select sum(number_of_gates) as total_gates_in_airpot from terminal;
```

4. Find the number of people in each job category working at the airport.

```
select job_type, count(*) as people_in_department from staff group by
job_type;
```

5. Find the number of terminals where each staff member works

```
select employee_id, count(*) as num_of_terminals_worked from
staff_terminal group by employee_id;
```

6. Number of people currently in the airport.

```
select count(*) from customers;
```

7. Count the number of hangars leased by each airline

```
select airline_name_abbr, count(*) as number_of_hangars_leased from
hangars group by airline_name_abbr;
```

8. Count the number of airlines running the same flight

```
select general_flight_num, count(primary_flight_num) from flight_details
group by general_flight_num;
```

9. Find the list of all the customers who are flying on the defined primary flight number.

```
select customer_name, customer_phone from customers where
primary_flight_num = "QAR769";
```

10. Find the list of all customers who are flying on the defined general flight number.

```
select customers.*, primary_flight from customers
    left join flight_details on customers.primary_flight_num =
flight_details.primary_flight_num
```

```
    left join secondary_flight_details on
flight_details.general_flight_num =
secondary_flight_details.general_flight_num
    where secondary_flight_details.general_flight_num = 'random1';
```

11. Find the next two flights to take off.

```
select * from secondary_flight_details order by take_off_time limit 2;
```

Security (Roles and Permissions)

Creating Roles

Three roles are assigned. Flight manager can add/remove flights from the schedule. Hangar Authorizer handles the leasing of hangars and updates the table with information about which hangars are leased. Customer is a role assigned to customers.

```
create role 'flight_manager';
create role 'hangar_authoriser';
create role 'customer';
```

Creating Users

```
create user 'read_only' identified by 'pa55';
create user 'allow_all' identified by 'skills';
create user 'customer_1' identified by 'hehe';
create user 'hangar_auth_1' identified by 'daboy';
create user 'flight_man_1' identified by 'daman';
```

Granting/Revoking Privileges

1. Allow a user to only read all values in the database

```
grant select on flight.terminal to 'read_only';
grant select on flight.lounges to 'read_only';
grant select on flight.hangars to 'read_only';
grant select on flight.flight_details to 'read_only';
grant select on flight.secondary_flight_details to 'read_only';
grant select on flight.staff_terminal to 'read_only';
grant select on flight.customers to 'read_only';
grant select on flight.staff to 'read_only';
```

2. Revoking read information on Customers and Staff because this may contain sensitive personal information which should not be accessible.

```
revoke select on flight.customers from 'read_only';
```

3. Granting all privileges on all tables in the flight database to a user

```
4. grant all on flight.* to 'allow_all';
```

5. Allowing customer (role) to run the procedure to retrieve flight information

```
grant execute on procedure flight.get_customer_info_from_view to
'customer';
```

6. Allowing hangar authority to manipulate the tables

```
grant update on flight.hangars to 'hangar_authoriser';
```

7. Allowing flight managers to add/remove entries to the relevant tables

```
grant update on flight.secondary_flight_details to 'flight_manager';
grant update on flight.flight_details to 'flight_manager';
```

Assigning/Revoking Roles

Each role created is assigned to a user which can be revoked later.

```
grant 'hangar_authoriser' to 'hangar_auth_1';
grant 'flight_manager' to 'flight_man_1';
grant 'customer' to 'customer_1';
revoke 'customer' from 'customer_1';
```

Additional SQL Features

1. A procedure is created to update the take-off time for the flight. If the flight is not found the error is handled and tells the user that the query did not work. Similar procedures can be constructed to update boarding start/end time.

```
delimiter //
create procedure update_take_off_time(in p_flight_num varchar(5), in
new_take_off_time datetime)
begin
    declare g_flight_num varchar(10);
    declare exit handler for sqlexception
    begin
        rollback;
        select 'Error Occurred. Could Not Update Take Off Time';
    end;
    set g_flight_num = (select general_flight_num from flight_details
                        where primary_flight_num = p_flight_num);
    update secondary_flight_details
        set take_off_time = new_take_off_time
        where general_flight_number = g_flight_num;
end //
delimiter ;
```

The first query will update the table. The second one will cause an error

```
call update_take_off_time('QAR769', '2023-05-26 14:35:53');
call update_take_off_time('pp', '2022-12-26 14:35:53');
```

2. This procedure can be used by a customer to log in and receive all of the information regarding their flights. Since most of the information is already compiled in the view it makes it simpler to retrieve the information.

```
delimiter //
create procedure get_customer_info_login(in customer_id varchar(20))
begin
    select your_flight_details.*, your_lounge.lounge_name from
your_flight_details
    left join your_lounge
    on your_flight_details.customer_id_number = your_lounge.customer_id_number
    where your_flight_details.customer_id_number = customer_id;
end //
delimiter ;
```

3. This creates an event that is scheduled to go off every minute. Once the take_off_time for the flight is past, it automatically deletes the record from the table. Since delete cascades, the relevant records from the flight_details and customers table are also deleted. This information can also be passed on to more archival storage where it can be stored there.

```
set global event_scheduler = on;
create event if not exists test_event
on schedule every 1 minute
starts now()
do
    delete from secondary_flight_details
        where datediff(take_off_time, now()) < 0.5;
```