ITCS413: Database Design

Project 2: Conceptual Database Design

Airline: Star Airline

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Prepared by

6588070 Nakarin Phoorahong

6588096 Panipak Sittiprasert

6588183 Achiraya Mankham

Presented To

Asst.Prof. Dr. Charnyote Pluempitiwiriyawej

Faculty of Information and Communication Technology, Mahidol University

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Overview

In this phase, we design the conceptual data model based on the information gathered and analyzed that we researched and made a report about it from phase 1. The model provides a clear, structured representation of the system's data, illustrating key entities, relationships, and attributes to guide database development. The model uses Chen' standard notations, and incorporates improvements to the data and transaction requirements based on initial findings. These changes ensure the model supports all necessary business processes while remaining adaptable for future needs.

Additionally, we define structural constraints, keys, and relationships according to business rules. We also create systemic pathways to verify processes to ensure the model supports all required transactions, providing a reliable foundation for subsequent database development.

User Requirements Specifications

Currently based on the previous section, we have identified users to be passengers, airline personnel, security officers, the Finance and Audit team, and Cargo Operators as a different group of users.

Data Requirements

The data required for efficient passenger, employees and cargo administration must be handled effectively by the airline database system. The primary entities and attributes include:

- **Passengers:** It is passenger information which include attributes such as PassengerID (PK), fullname, phone number, email.
- **Flights:** Flight information which includes attributes such as FlightID(PK) , FlightNumber, FlightStatus, departure and arrival airports, departure and arrival times, NextFlightID, and aircraft type.
- **Bookings:** Manages reservations, linking passengers to flights. It has BookingID (PK) , PaymentStatus, and Booking status as attributes.
- **Passenger Bookings:** Links multiple passengers to a single booking, supporting family and group reservations. It has classType and SeatNo as attributes.
- **Flight Classes:** Defines different seat classes (Economy, Business, First Class) with pricing and availability. It has ClassID (PK) , ClassType, Price, SeatAvailability as attributes.
- **Check-in:** Tracks passenger check-in status and luggage details. It has CheckInID (PK), CheckInStatus, and LuggageCount as attributes.
- **Cargo Shipments:** Manages cargo transfers, tracking shipment statuses. It has CargoID (PK) , CargoStatus, TrackingNumber, SenderName, and ReceiverName as attributes.
- **Payments:** Stores transaction details for passenger tickets and cargo bookings. It has paymentID (PK) , amount, paymentMethod, and paymentStatus as attributes.
- **Security Logs:** Monitors system access for compliance and security. It has LogID (PK) , Date, Details, SystemAreaAccess, and Action Type as attributes.
- **Airline Employee :** It has attributes such as EmployeeNumber(PK), Employee first name, Employee last name, Email, Job Title, and contact number.

Transaction Requirements

The airline database system must support essential operations such as insert, delete, update, and look-up/search queries to ensure smooth and efficient functionality.

Data Insertion or Data Entry

Data insertion can be performed by different user groups based on their roles and access privileges.

- **Passengers:** Passengers can enter their personal information, manage bookings, and provide flight preferences.
- **Airline Employee:** Airline personnel generally have most of the privilege to insert in most of the tables that exist.
- **Security Officers:** Security officers can only insert data into Security Logs for access tracking and security events.
- **Finance and Audit team:** The Finance and Audit team can insert records exclusively into the Financial Database for transactions and audits.
- **Cargo Operators:** Cargo operators can only write into the cargo database.

Data Deletion/Update

Authorized users can delete or modify data within their permitted domains.

- **Passengers:** Passengers can access, delete and modify their information from the passenger's database, reservation database.
- **Airline Employee:** Airline Personnel can delete and modify data from almost every table in the database.
- **Security Officers:** Security officers can delete and modify data from Security logs and can modify from the reservations database and cargo database.
- **Finance and Audit team:** The Finance and Audit team can delete and modify data from the finance database.
- **Cargo Operators:** Cargo operators can only delete and modify data from the cargo database.

Data Queries

The system must provide query capabilities to retrieve and analyze information from various databases and tables.

This table shows an example of queries that typical airlines usually do have.

Query Type	Example
Basic Lookup	Find all flights, passengers, and cargo with specific conditions such as time and location Find all payment information. Find passengers' class type. Find all available seats on a specific flight. Find security reports in specific conditions.
Aggregate Query	Count total passengers on a specific flight, Count the total number of cargo in a specific time, Count the number of flights in a specific time, Find the total revenue from passenger’ booking in specific time period,
Reporting Query	Monthly revenue from cargo shipments
Real-Time Query	Fetch current flight delays

Database Specification Changes

The Database Specification Changes reflect improvements made based on feedback from Phase 1 and updated system requirements. These changes ensure better functionality, performance, and reliability across the airline's database system.

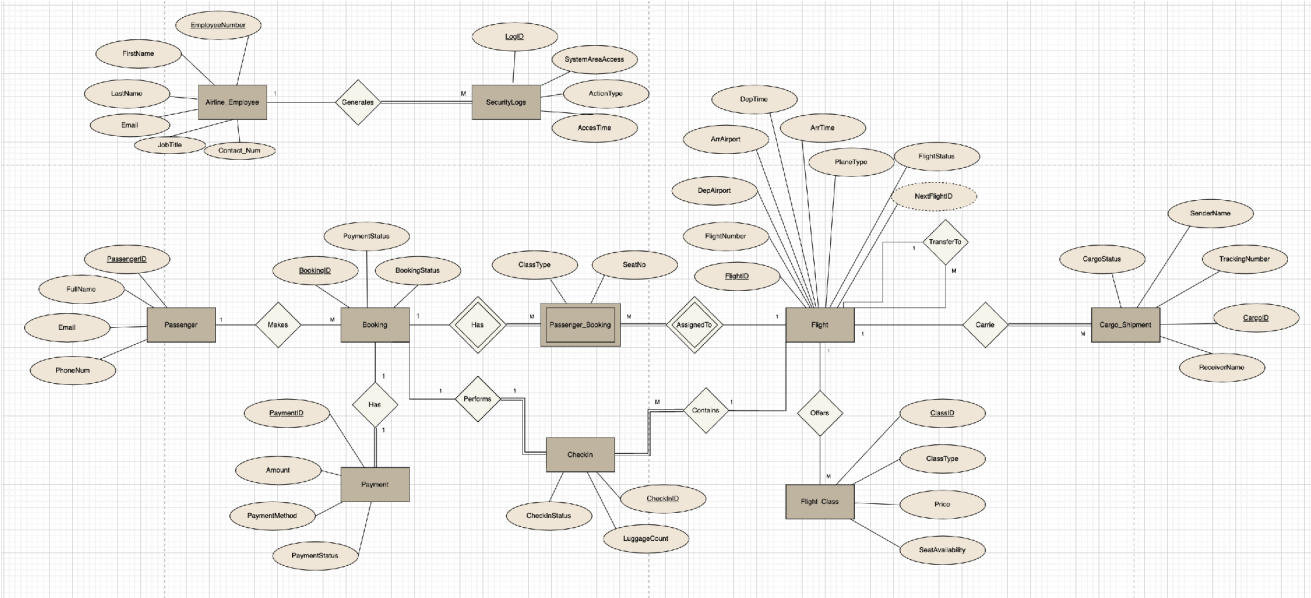
The modifications are as follows:

1. **Passenger Bookings table:** To manage group reservations by linking multiple passengers to a single booking, simplifying seat allocation and payments.
2. **Flight Status Column:** Added to the Flights table to track real-time statuses like Scheduled, Delayed, Cancelled, and Departed, enhancing passenger communication.
3. **Seat Availability Column:** The Flight Classes table now tracks available seats, The system automatically updates this field when seats are booked, canceled, or upgraded, ensuring accurate availability information during the booking process.
4. **Tracking Updates Table:** A new table logs cargo shipment locations, timestamps, and statuses (In Transit, Arrived, Delayed), improving cargo management.
5. **Payment Constraints:** Added unique transaction ID and timestamp validation to prevent duplicate payments and ensure financial accuracy.
6. **Enhanced Indexing:** Indexing improvements in high-traffic tables like Passengers, Flights, and Bookings result in faster searches and better query performance.
7. **Airline Personnels and its subclass to Airline Employee:** change from personnel to employee, discard the subtypes of it, and discard some attributes such as dateofBirth, Employee nickname, Position, Department, Employee status, emergency contact and access level.

Conceptual Data Model

Entity-Relationship Diagram (ERD)

Link to the actual ERD:
https://drive.google.com/file/d/1i66qccHv3FzlbKokBrmWAM0ExGCBViX5/view?usp=sharing



Entities

- **Passengers:** It is passenger information which includes attributes such as PassengerID (PK), fullname, phone number, email.
- **Flights:** Flight information which includes attributes such as FlightID(PK) , FlightNumber, FlightStatus, departure and arrival airports, departure and arrival times, NextFlightID, and aircraft type.
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- **Airline Employee :** It has attributes such as EmployeeNumber(PK), Employee first name, Employee last name, Email, Job Title, and contact number.

Relationship in ERD

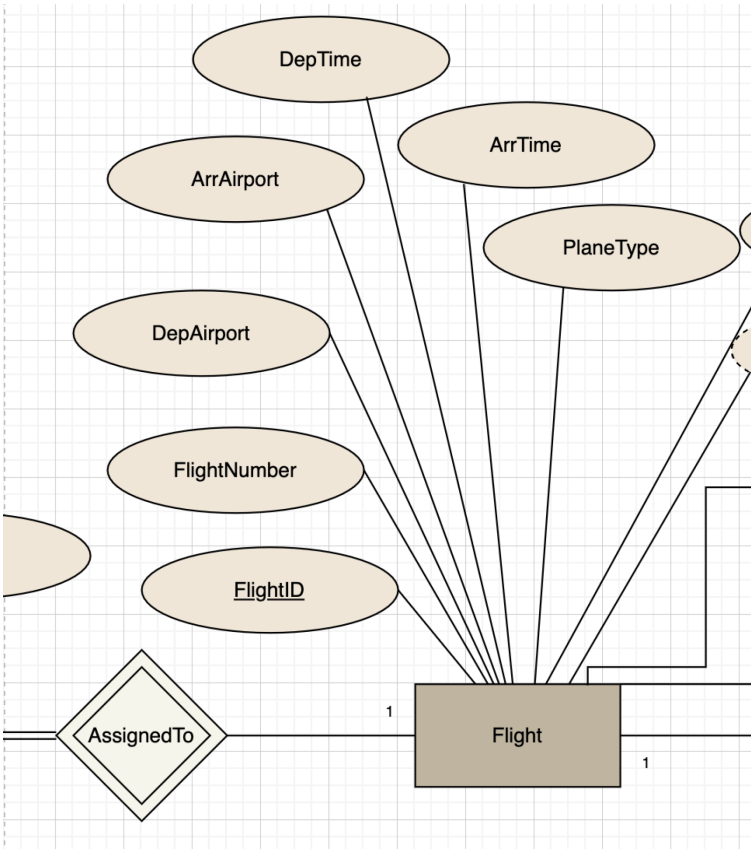
1. **Passengers Makes Booking:** A passenger can make at least 1 booking and each booking can be made by many passengers.
2. **Booking has passenger_booking:** One booking can include multiple Passenger_Booking, and each Passenger_Booking can be linked to multiple bookings.
3. **Booking performs CheckIn:** One Booking can perform only one CheckIn, and One CheckIn can be performed by only one Booking.
4. **Booking Has Payment:** Each Booking is linked to one Payment, and each Payment is associated to one Booking.
5. **Passenger_Booking assigned to flights:** One Flight can have many Passenger_Booking entries, and one Passenger_booking can be assigned to multiple bookings.
6. **Flight offers Flight class:** One Flight can have multiple classes, but each Flight_Class is linked to a specific Flight.
7. **Flight carrie Cargo_Shipment:** One Flight can carry multiple cargo shipments, and multiple cargo shipments can be carried by one flight.
8. **Flight contains CheckIn:** One Flight can contain multiple CheckIn records, but each CheckIn is linked to only one Flight.
9. **Flight transfers to:** One Flight can have multiple next Flights, but each nextFlightID points to one specific Flight.
10. **Airline_Employee generates SecurityLogs:** One airline_Employee can generate multiple SecurityLogs, but each SecurityLog entry is generated by one specific Airline_Employee.

Pathways

The verification pathway for proving that the conceptual data model that we just created supports all of the users' transactions.

1. **Find all flight in this week**

   Query flights' information from the flight by specifying the condition of Departure Time (Deptime) and Arrive Time (ArrTime).

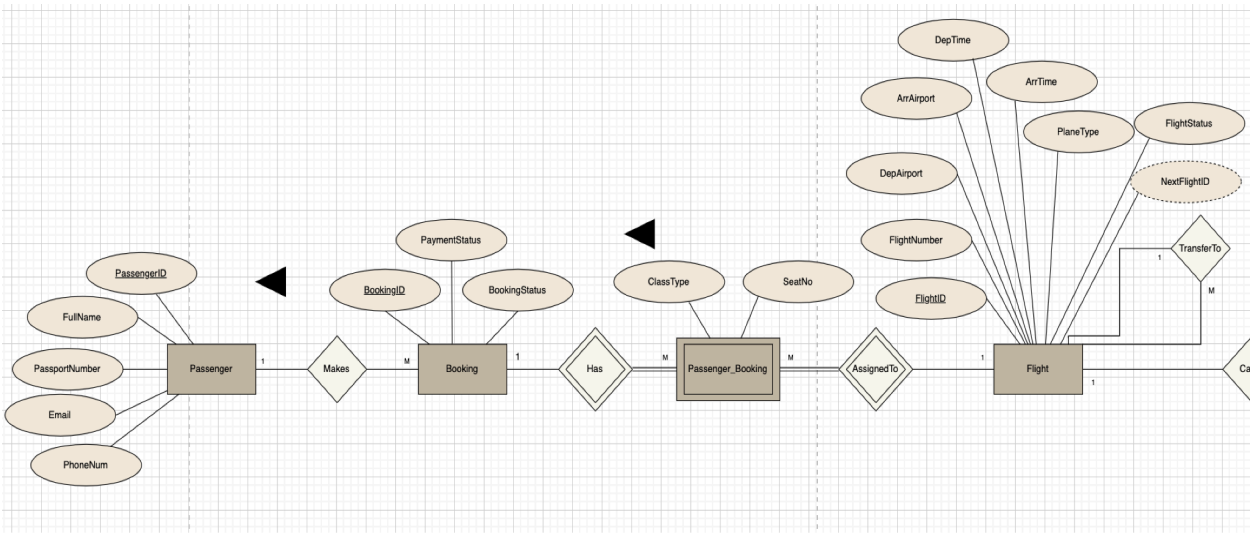


Explanation:

- The system retrieves all flights from the Flight entity where the Deptime and ArrTime fall within the current week.
- This requires the Flight entity to have attributes for Deptime and ArrTime, and the ability to filter records based on date ranges.
- The query should return flight details such as flight number, departure and arrival times, origin, destination, and status.

2. **Find all passengers on the specific flight**

   From flight to passenger_booking then to booking and getting through passengers in the end.

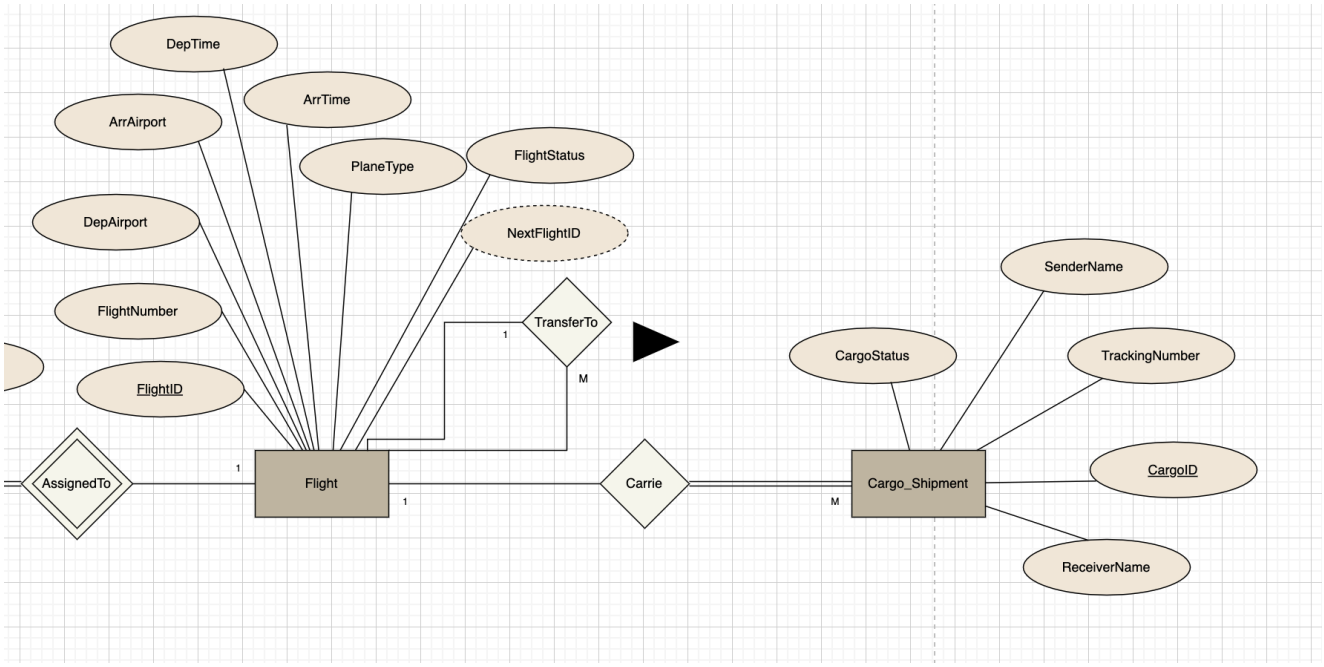


Explanation:

- Start with the Flight entity to identify the specific flight.
- Use the Passenger_Booking entity to link the flight to the bookings made for that flight.
- From Booking, retrieve the associated Passenger records to get the list of passengers on the flight.
- This pathway ensures that the data model supports many-to-many relationships between flights and passengers through bookings.

3. **Find cargo with specified date or cargoID**

   From flight to cargo_shipment then specify the cargo_id

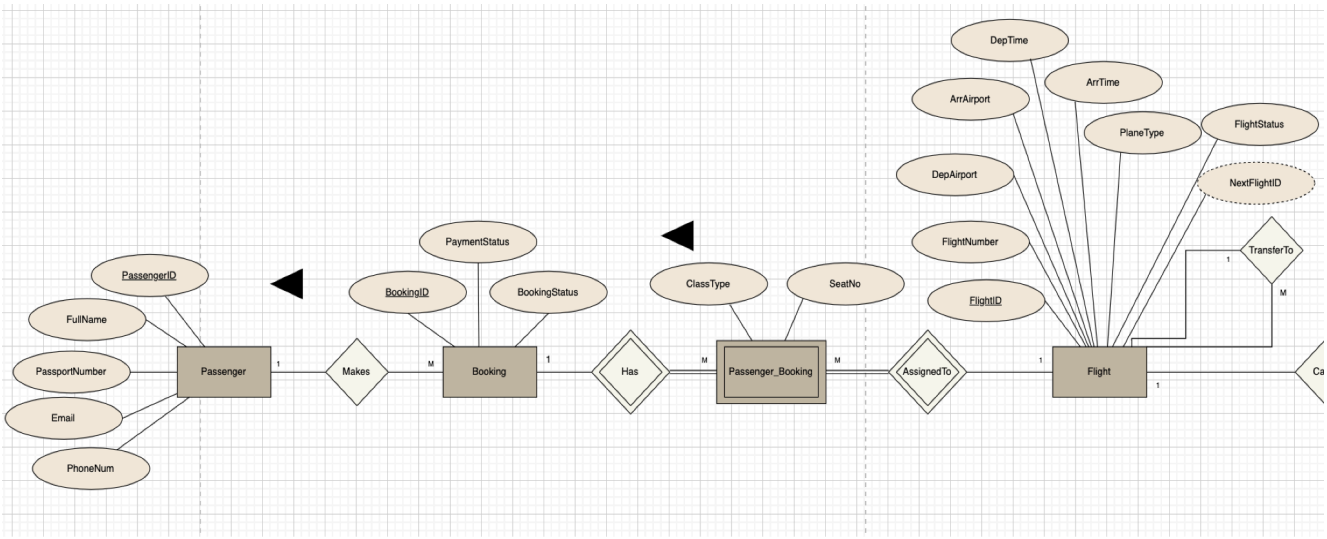


Explanation:

- It can be two types from flight or directly from cargo_shipment.
- From Flight perspective, It is in the case of cargo shipped along with passengers.
- In the case of cargo alone, cargo_shipment can search from cargo_ID that has been specified.

4. **Count the number of passengers for a specific flight**

   Similar to the case of finding passengers information, It starts from flight to passenger_booking to booking status and to passengers.

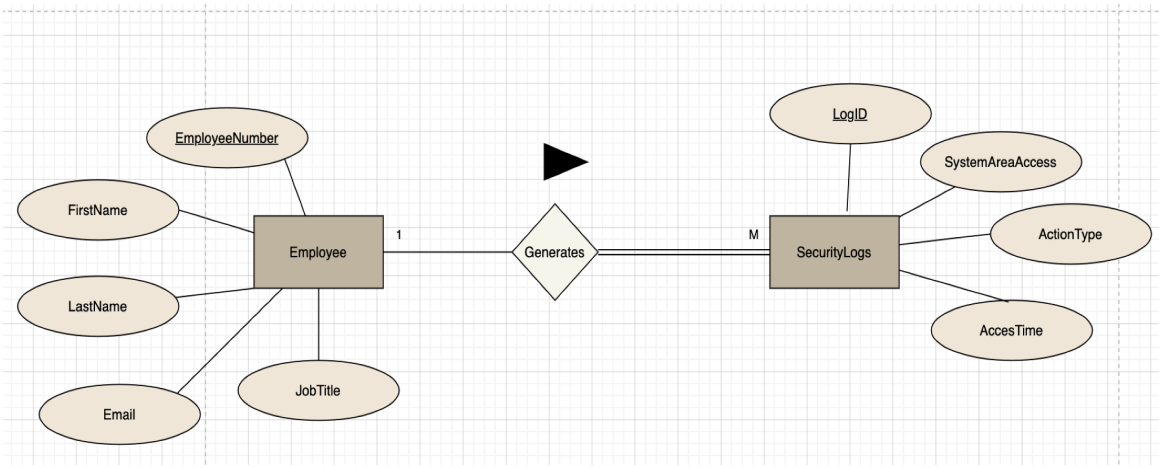


Explanation:

- Similar to finding passengers, this pathway starts with the Flight entity and navigates through Passenger_Booking and Booking to reach the Passenger entity.
- Instead of retrieving passenger details, the system aggregates the count of passengers associated with the specific flight.
- This requires the data model to support counting operations on related entities.

5. **Find security reports for specific period of time**

   Security officers and related airline personnels can generate and access reports via SecurityLog.

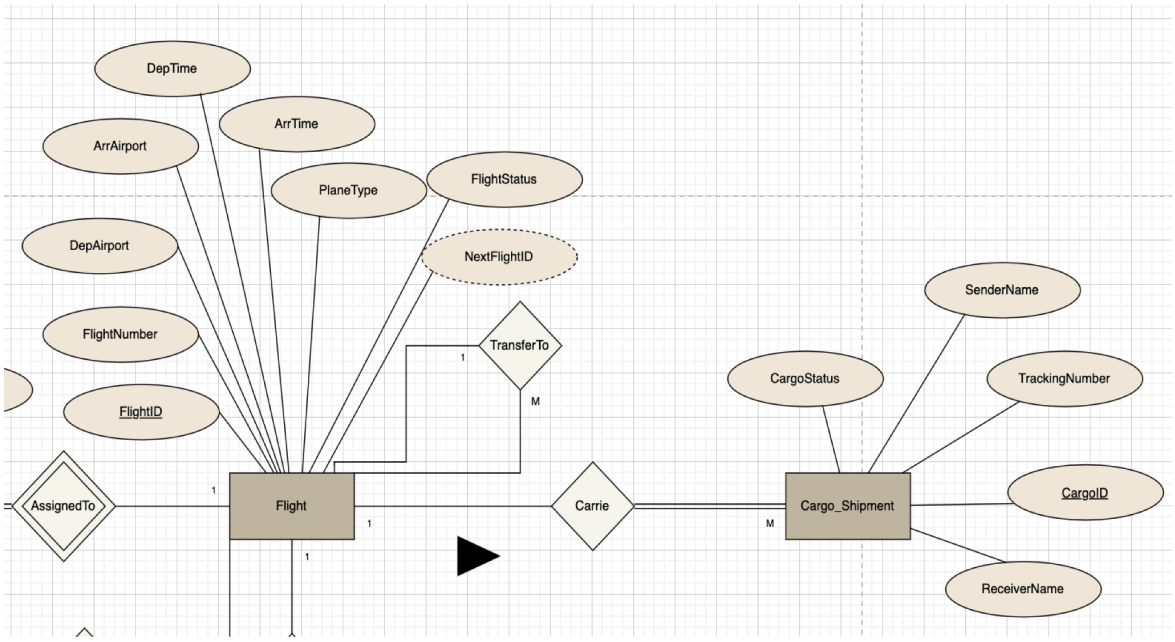


Explanation:

- Security officers and airline personnel can query the SecurityLog entity to retrieve reports for a specific time period.
- The SecurityLog entity should include attributes such as log_date, event_type, description, and officer_id to support filtering and reporting.
- This pathway ensures that security-related data is accessible and can be analyzed for specific timeframes.

6. **Count the number of cargo in a specific time both type (with passengers and cargo only)**

   In the case of flights that carry passengers along with cargo, then flight will be needed, but in the case of cargo alone, flight will not be included because we can directly go to cargo_shipment directly.

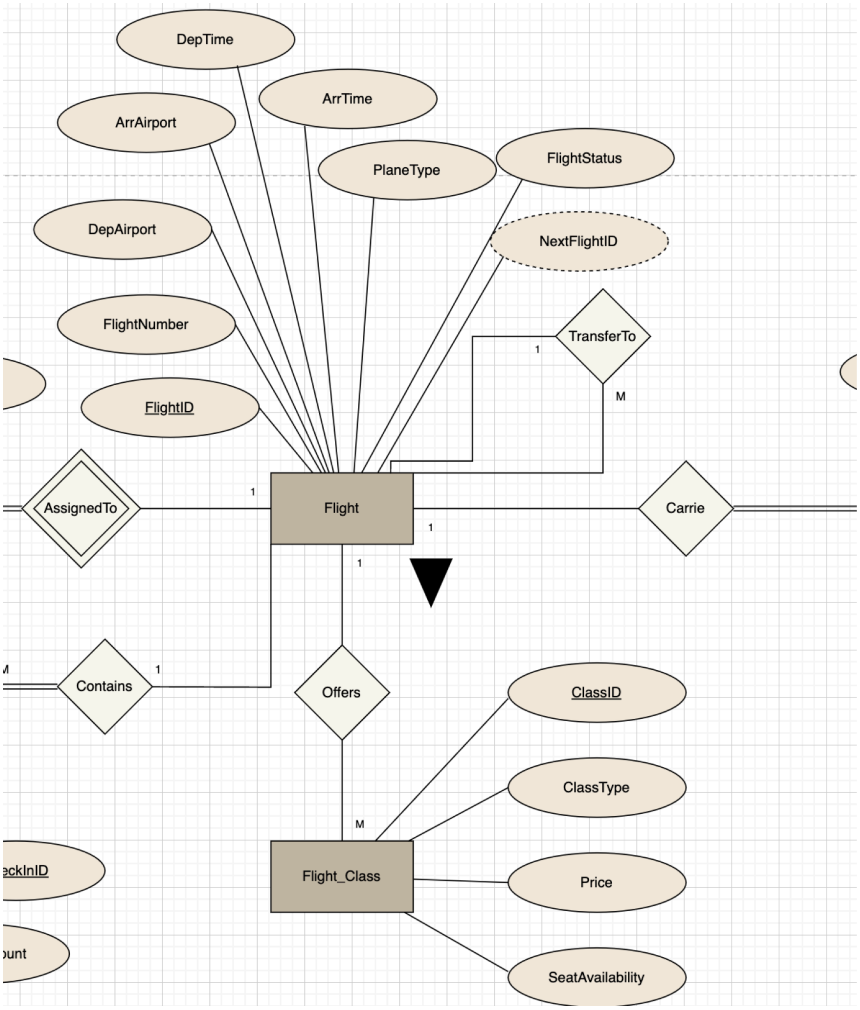


Explanation:

- For cargo shipped on passenger flights, start with the Flight entity and navigate to Cargo_Shipment to count the cargo.
- For cargo-only shipments, directly query the Cargo_Shipment entity to count the cargo.
- This ensures that the system can handle both types of cargo shipments and provide accurate counts.

7. **Find all seat available in specific flight**

   It starts from flight then goes to Flight_class.



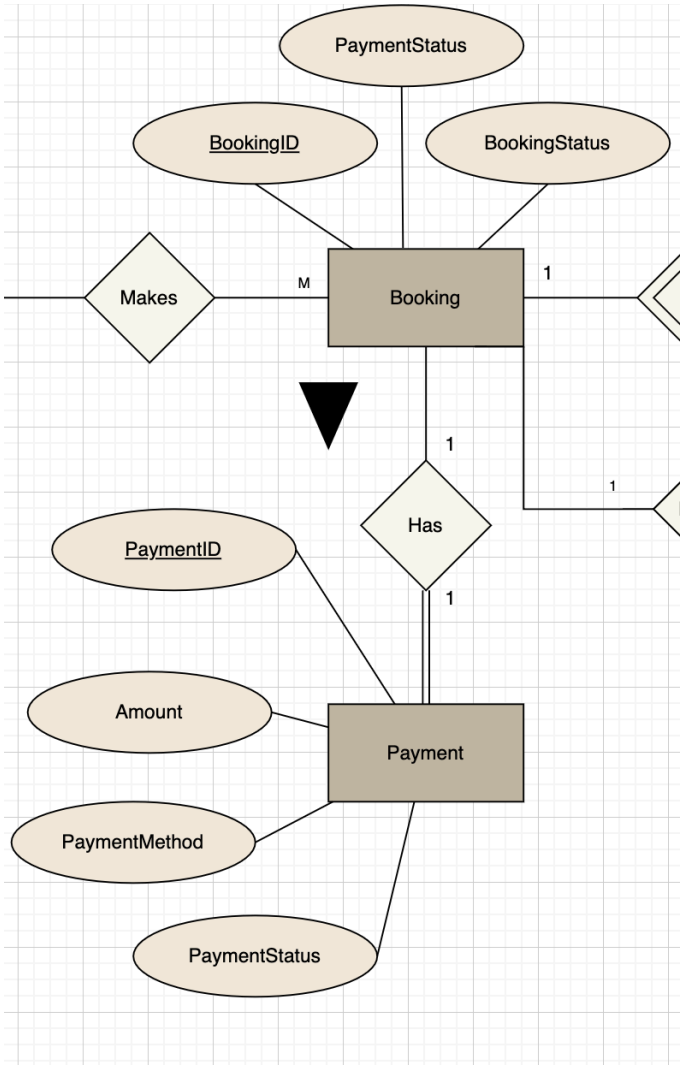
Explanation:

- Start with the Flight entity to identify the specific flight.
- Navigate to the Flight_Class entity to retrieve information about available seats in each class (e.g., economy, business, first class).
- This pathway ensures that the data model supports seat availability queries for specific flights.

8. **Find all payment information**

   Start from booking and then payment. If it does not have any further details.

   This pathway can be used for the case aggregation of payment information as well.

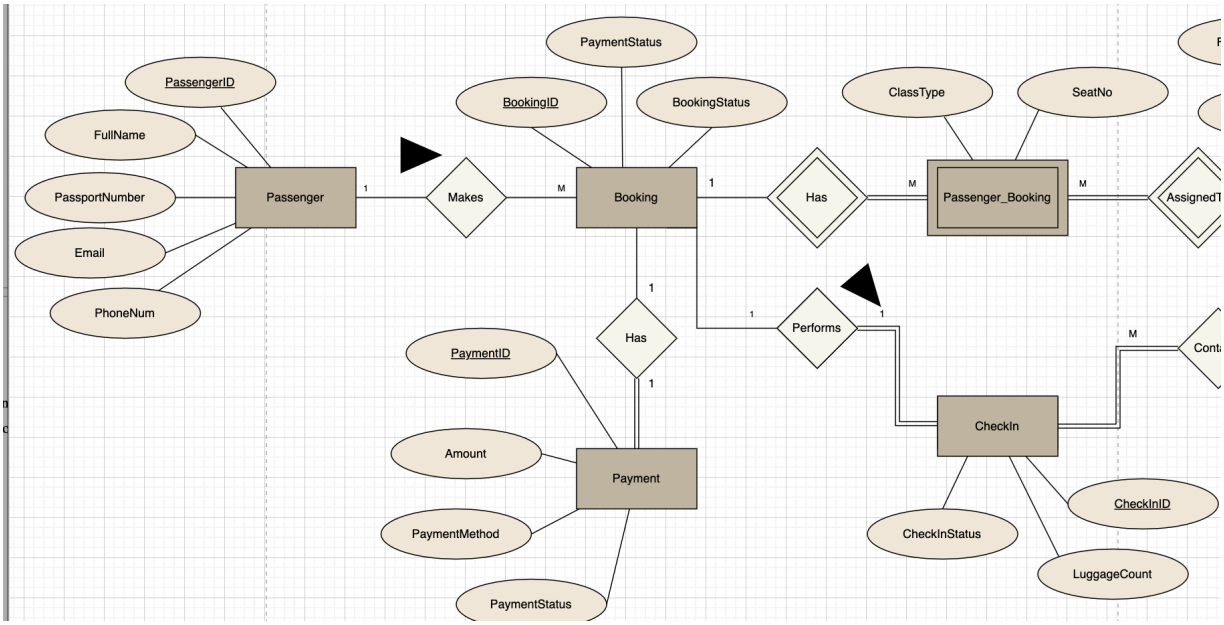


Explanation:

- Start with the Booking entity to identify the booking for which payment information is required.
- Navigate to the Payment entity to retrieve payment details such as payment method, amount, and status.
- This pathway can also be used for aggregating payment information across multiple bookings.

9. **Find passengers and checkIn information**

   It starts with the Passenger then goes to the booking and checks in to get information from both.



Explanation:

- Start with the Passenger entity to identify the passenger.
- Navigate to the Booking entity to retrieve the booking details.
- From Booking, navigate to the CheckIn entity to retrieve check-in information such as check-in time, seat number, and boarding status.
- This pathway ensures that the data model supports retrieving combined passenger and check-in information.

Changes from Phase 1

Some modifications are as follows:

Data Requirements

- **Security Officers:** Additional details include shift schedule and certification.
- **Finance and Audit Team:** Additional attributes include certification.
- **Cargo Operators:** Additional details include shift schedule and certification.

Data Insertion or Data Entry

- **Security Officers:** Security officers can only insert data into Security Logs for access tracking and security events.
- **Finance and Audit team:** The Finance and Audit team can insert records exclusively into the Financial Database for transactions and audits.
- **Cargo Operators:** Cargo operators can only write into the cargo database.

Data Deletion/Update

- **Security Officers:** Security officers can delete and modify data from Security logs and can modify from the reservations database and cargo database.
- **Finance and Audit team:** The Finance and Audit team can delete and modify data from the finance database.
- **Cargo Operators:** Cargo operators can only delete and modify data from the cargo database.

Data Queries

- **Reporting Query:** Monthly revenue from cargo shipments
- **Real-Time Query:** Fetch current flight delays

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