Teaching Case

Dragon Air: A Database Design Case

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Abstract

This case describes a real-world scenario based on a fictional new commuter airline seeking to develop a database to support their operations. Students are asked to design and develop a database to allow the airline to track flights, passengers, bookings, and more, based on a set of business rules, default data, and other requirements. The case has been designed for use in a database management course for students having little relational database experience other than the content of the course itself. Teaching notes containing suggestions and a possible solution are provided upon request.

Keywords: Database Management, Database Design, Entity-Relationship Diagrams, SQL.

1. COMPANY INFORMATION

Dragon Air is a new low-cost airline startup, with headquarters in Dayton Ohio. Initially, their focus will be on providing commuter flights between mid-size airports in the US. They have contracted your firm to develop a new reservation system to track flights, planes, crew, customers, and bookings. Your team's assignment is to develop the relational database to support the operational requirements of the new reservation system.

2. DATA REQUIREMENTS AND BUSINESS RULES

The company has identified a number of data elements and associated requirements, each of which needs to be included in the database. These rules concern the data associated with the flight destinations, flights, tickets, passengers, planes, and crew members. Additional information regarding the initial flight schedules, airport information, and their fleet of planes is included in the appendix.

Destinations

Dragon Air will initially fly to 11 cities in the United States. The cities are listed below. Eventually, it is expected that they will fly to many more cities in the US and around the world. Each city is identified by a three-letter code assigned according to the IATA (International Air Transport Association) standard.

IATA Code	City
ABQ	Albuquerque NM
BUF	Buffalo NY
DAY	Dayton OH
GSP	Greenville SC
JAX	Jacksonville FL
MSY	New Orleans LA
PDX	Portland OR
SAC	Sacramento CA
SAT	San Antonio TX
TUS	Tucson AZ
TYS	Knoxville TN

Table 1. List of Destinations

Tickets and Bookings

All tickets are paid in advance, at the time of booking. Each booking has a unique 6-character booking ID, date, flight number, price, status

(booked, cancelled, abandoned, etc.), and any airport taxes paid. Also, each booking is subject to a 7.5% Domestic Passenger Tax (payable to the FAA) and a $4.00 charge for each leg of the flight. Round trip tickets (i.e. in both directions between two cities) are counted separately. For instance, a round trip ticket between Buffalo and Dayton is recorded and billed as two flights: Buffalo to Dayton and Dayton to Buffalo.

Each booking is paid by a single customer, who may or may not be one of the flying passengers. Each booking is associated with a single payment, but a customer may pay for several bookings on the same payment. Dragon Air accepts payment by credit card or checks only. The relevant information for both payment types will need to be stored (e.g. card number, expiration, check number, account number, etc.).

At booking, the passengers may choose to select their seat in advance for $25 extra. Regardless, when seats are assigned, this must be tracked in the database as well. Also, each passenger may prepay for their luggage. These costs are added to the booking price as needed. If the luggage is not prepaid, the passenger may pay at the airport. Baggage costs are shown below.

Item	Carry-on	Checked
Prepaid luggage	$20	$25
At the airport	$50	$50

Table 2. Baggage Fee Chart

Passenger Information
We need to track the name, date of birth, passport country and number, email, mobile phone, and address information for each passenger. These passengers accumulate miles for each flight (regardless of who pays for it). Once they accumulate 50,000 miles, they become members of the Silver Flyers club. At 100,000 miles, they become members of the Golden Flyers club. This designation allows them to board flights earlier and to get upgrades to premium seats. Their flyer status is active for one year from the date it is activated (so this date needs to be tracked in their account). For each flight, we need to be sure that the passenger checked in at the airport on the scheduled date of the flight.

Flights
For each flight between two cities, DA needs to track the flight number, departure and arrival cities, the miles for each flight, the days of the week on which they are scheduled, and the scheduled departure and arrival times. They also need to track the airport taxes for both airports. Each flight occurs once on each scheduled day. For each individual flight, we need to track the actual departure and arrival times. We also need to know the plane which flew each individual flight, and the crew (pilot, co-pilot, and 4 flight attendants).

Planes
For each plane, DA needs to track the FAA number, plane type (e.g. 737-700, 787, etc.), the current status (e.g. in service, out for repairs, retired, etc.) and the airport hangar where it is based. DA also wants to track the maintenance visits for each plane, including the date of service, the type of service performed, and the results of the service.

Crew
DA employs six crew members for each flight: pilot and co-pilot and four flight attendants. The crew members on each flight need to be identified, including their advance schedule for the next few months. Although there are stringent regulations on how often a crew member can fly, this is not tracked or monitored within this database at this time. Currently, there are over 650 crew members in the database, including 180 pilots/co-pilots.

3. REQUIRED TASKS

The database must be able to support each of the tasks and outputs listed below.

1. Book a flight for a passenger.
2. Pay for a booking. Remember: multiple passengers may eventually be associated with a single payment.
3. Add a new 737-800 airplane (NX6471DA) to the fleet, with a capacity of 205 passengers.
4. Schedule crew members for a given flight on a given date.
5. Change a crew member on a given flight due to illness.
6. Change a passenger's flight to the next day.
7. Change the price of a flight.
8. Add a baggage fee for a customer at the airport.
9. Add new crew members (1 pilots and 1 flight attendant).
10. Change the departure date and time for a flight scheduled for a given date/time.

(For instance, assume there is a one hour weather delay.)

4. Desired Outputs

Dragon Airlines' managers need to make decisions regarding their daily operations. To support their efforts, they have identified an initial set of information outputs that the database should support.

1. Scheduled flights, by date
   Show each flight scheduled on a given date. Show all flight information, including scheduled times and plane types.
2. Scheduled flights by date, restricted by airport.
   Show all flights scheduled on a given date, but only for a particular airport.
3. Capacity Report
   Show the capacity for all flights on a given date. This includes flight number, origin, destination, number of bookings, and capacity.
4. Passenger Manifesto
   Show all passengers scheduled and checked-in for a given flight.
5. Capacity Report Summary, by date range
   Show the total capacity and bookings for each date, summarized for a given start and end date.
6. Passenger history
   Show all flights taken by a given passenger, with miles and cost. Also, note if the passenger is a member of the Silver or Golden Flyers club, with the date their membership expires.
7. Bookings History
   Show all bookings paid for by a given customer. Note that this is different from the passengers that took a flight.
8. Silver Flyers / Golden Flyers
   Print a list of all Silver and Golden Flyers, sorted by the miles flown, including the passengers' name and total miles flown.
9. Booking Receipt
   Show all information associated with a given booking; i.e. booking customer, passengers, total price, total baggage fees paid in advance, scheduled times, and payment information.
10. Revenue Report by date range
    Show the total revenues booked on all flights between a given start and end date.
11. Revenue Report by flight
    Show the total revenues booked on a given flight.
12. Max Miles
    Show the top 5 passengers, in terms of the total number of miles accumulated on flights they have taken.
13. Max Flights
    Show the top 5 passengers, in terms of the total number of flights taken.
14. Passenger Schedule
    Show the flight information for all upcoming flights for a given passenger.
15. Plane Aging Report
    Show the total number of miles flown for each plane.
16. Crew Schedule
    Show the scheduled flights for a given crew member.
17. Crew Assignments
    Show all crew members scheduled for a given flight
18. Maintenance history
    Show all maintenance actions for a given plane.
19. Plane model history
    Show the number of maintenance events by the type of plane. If possible, distinguish routine maintenance from malfunctions, repairs, or other service issues.
20. Flight Discrepancy Report
    Show any flights where the actual departure/landing time differs from the scheduled times.

Editor's Note:

This paper was selected for inclusion in the journal as an EDSIGCON 2017 Distinguished Paper. The acceptance rate is typically 7% for this category of paper based on blind reviews from six or more peers including three or more former best papers authors who did not submit a paper in 2017.

Appendix

City Information

IATA Code	City	Time Zone	Latitude and Longitude
ABQ	Albuquerque	Mountain	35.0433° N, 106.6129° W
BUF	Buffalo	Eastern	42.9397° N, 78.7295° W
DAY	Dayton	Eastern	39.9025° N, 84.2218° W
GSP	Greenville	Eastern	34.8504° N, 82.3514° W
JAX	Jacksonville	Eastern	30.4941° N, 81.6879° W
MSY	New Orleans	Central	29.9922° N, 90.2590° W
PDX	Portland	Pacific	45.5898° N, 122.5951° W
SAC	Sacramento	Pacific	38.6951° N, 121.5901° W
SAT	San Antonio	Central	29.5312° N, 98.4683° W
TUS	Tucson	Mountain	32.1145° N, 110.9392° W
TYS	Knoxville	Eastern	35.8108° N, 83.9939° W

Aircraft Fleet Information

FAA Number	Plane Type	Capacity	Base
NX3377DA	737-800	160	ABQ
NX3521DA	737-700 ER	125	PDX
NX3594DA	767	200	DAY
NX3598DA	737-700	135	DAY
NX3609DA	737-700	135	SAT
NX3669DA	767	200	JAX
NX3704DA	737-700	135	ABQ
NX3897DA	737-700	135	SAC
NX3911DA	737-700 ER	125	TYS
NX4466DA	737-700	135	TYS
NX4592DA	737-800	160	PDX
NX4602DA	737-700	135	TYS
NX4770DA	767	200	DAY
NX4787DA	737-700	135	GSP
NX4845DA	767	200	JAX
NX4869DA	737-800	160	MSY
NX4928DA	737-700	135	BUF
NX4952DA	737-700	135	TYS
NX5052DA	737-700	135	GSP
NX5114DA	737-700	135	TUS
NX5165DA	737-700 ER	125	MSY
NX5641DA	737-700	135	JAX
NX5717DA	737-700	135	JAX
NX6070DA	737-700	135	SAC
NX6740DA	737-800	160	BUF
NX6784DA	737-700 ER	125	PDX
NX6813DA	737-800	160	SAT
NX6862DA	737-800	160	DAY
NX6864DA	737-700	135	DAY
NX6871DA	737-700 ER	125	TUS
NX7016DA	737-800	160	MSY
NX7037DA	737-700 ER	125	PDX

Flight Schedule

Flight#	From	To	Departure	Arrival	Miles	Minutes	Price	Flight Days
484	Albuquerque	Buffalo	7:05:00 AM	12:32:00 PM	1585	207	$ 310	MTWRF
167	Albuquerque	Dayton	11:33:00 AM	4:59:00 PM	1269	206	$ 235	MTWRF
697	Albuquerque	San Antonio	2:00:00 PM	4:31:00 PM	609	91	$ 148	
279	Albuquerque	Tucson	11:35:00 AM	1:05:00 PM	321	90	$ 100	
515	Buffalo	Albuquerque	2:17:00 PM	3:44:00 PM	1585	207	$ 279	MTWRF
257	Buffalo	Dayton	12:28:00 PM	1:51:00 PM	353	83	$ 104	
183	Buffalo	Portland	4:02:00 PM	5:34:00 PM	2151	272	$ 385	MTWRF
554	Buffalo	Sacramento	11:45:00 AM	1:14:00 PM	2236	269	$ 384	MTWRF
180	Dayton	Albuquerque	8:22:00 AM	9:48:00 AM	1269	206	$ 245	MTWRF
685	Dayton	Buffalo	9:20:00 AM	10:43:00 AM	353	83	$ 107	
663	Dayton	Jacksonville	11:30:00 AM	1:00:00 PM	666	90	$ 151	
133	Dayton	Sacramento	6:50:00 AM	8:18:00 AM	1985	268	$ 373	
153	Greenville	Portland	5:27:00 PM	7:02:00 PM	2222	275	$ 381	MWF
138	Greenville	New Orleans	5:24:00 PM	6:03:00 PM	570	99	$ 136	MTWRF
506	Greenville	San Antonio	10:19:00 AM	11:50:00 AM	1010	151	$ 193	MTWRF
204	Greenville	Knoxville	5:00:00 PM	5:29:00 PM	114	29	$ 67	MTWRF
263	Jacksonville	Dayton	2:45:00 PM	4:15:00 PM	666	90	$ 147	
537	Jacksonville	Portland	9:15:00 AM	11:54:00 AM	2424	339	$ 406	MTRFSU
500	Jacksonville	Sacramento	5:51:00 PM	8:27:00 PM	2320	336	$ 423	
158	Jacksonville	Knoxville	12:33:00 PM	2:06:00 PM	391	93	$ 109	
462	New Orleans	Greenville	1:00:00 PM	3:39:00 PM	570	99	$ 136	MTWRF
541	New Orleans	Portland	8:04:00 PM	10:48:00 PM	2047	284	$ 345	MWF
579	New Orleans	Sacramento	7:20:00 AM	10:01:00 AM	1875	281	$ 318	MTWRF
306	New Orleans	Tucson	1:15:00 PM	2:54:00 PM	1230	159	$ 250	MTWRF
243	Portland	Buffalo	6:45:00 AM	2:17:00 PM	2151	272	$ 406	MTWRF
190	Portland	Greenville	7:22:00 AM	2:57:00 PM	2222	275	$ 389	MWF
108	Portland	Jacksonville	1:39:00 PM	10:18:00 PM	2424	339	$ 448	MTRFSU

481	Portland	New Orleans	10:50:00 AM	5:34:00 PM	2047	284	$	377	MWF
200	Sacramento	Buffalo	3:44:00 PM	11:13:00 PM	2236	269	$	377	
455	Sacramento	Dayton	10:33:00 AM	6:01:00 PM	1985	268	$	351	
583	Sacramento	Jacksonville	6:45:00 AM	3:21:00 PM	2320	336	$	407	
608	Sacramento	New Orleans	2:20:00 PM	9:01:00 PM	1875	281	$	344	MTWRF
270	San Antonio	Albuquerque	6:16:00 PM	6:47:00 PM	609	91	$	137	
176	San Antonio	Greenville	2:20:00 PM	5:51:00 PM	1010	151	$	196	MTWRF
587	San Antonio	Knoxville	2:20:00 PM	5:50:00 PM	946	150	$	192	
555	San Antonio	Tucson	11:40:00 AM	1:11:00 PM	760	151	$	168	
444	Tucson	Albuquerque	2:50:00 PM	4:20:00 PM	321	90	$	102	
303	Tucson	New Orleans	4:39:00 PM	8:18:00 PM	1230	159	$	230	MTWRF
414	Tucson	San Antonio	3:41:00 PM	7:12:00 PM	760	151	$	169	
269	Tucson	Knoxville	2:04:00 PM	7:33:00 PM	1560	209	$	279	
456	Knoxville	Greenville	8:00:00 AM	8:29:00 AM	114	29	$	68	MTWRF
470	Knoxville	Jacksonville	9:15:00 AM	10:48:00 AM	391	93	$	110	
598	Knoxville	San Antonio	11:05:00 AM	12:35:00 PM	946	150	$	192	
187	Knoxville	Tucson	10:50:00 AM	12:19:00 PM	1560	209	$	307	