PASSENGER TRIP DELAYS IN THE U.S. AIRLINE TRANSPORTATION SYSTEM IN 2007

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Abstract— **The value of the air transportation system is the transportation of light-weight, high-value cargo, and passengers. Industry and government metrics for the performance of the air transportation focus on the performance of the flights. Previous research has identified the discrepancy between flight performance and passenger trip performance, and has developed algorithms for the estimation of passenger trip performance form publicly available data.**

This paper describes an analysis of passenger trip delays for 5224 routes between 309 air ports in the U.S. air transportation system for 2007. The average trip delay experienced by passengers was 24.3 minutes for nationwide total of 247 Million hours. Flights delayed 15 minutes or more contributed 48% of the total delays, cancelled flights 43%, diverted flights 3%, and flights delayed less than 15 minutes contributed the remaining 6%. Passenger trip delays for oversold flights were negligible. Analysis of passenger trip delays for routes and airports, and the implications of these results are also discussed.

Keywords- passenger trip delay; flight delay, airport delay.

I. INTRODUCTION

The value proposition of the air transportation system is the rapid, safe, and cost effective transportation of high-value, lightweight cargo, and human passengers. This transportation is achieved by combining air transportation between airport terminals with ground transportation between origin (e.g. home)/destination (e.g. meeting) and the airport. The air component of the transportation is achieved through via single segment or multiple connecting segment scheduled airline operations.

To leverage economies of scale, airlines schedule and operate a daily itinerary that networks passengers, aircraft, flight, and cabin crews in connecting segments throughout the day. Individual flights on a segment may be delayed for several reasons such as: (e.g. mechanical) problems, weather, or traffic congestion. To maintain integrity of their networks in the presence of individually delayed flights, airlines may choose to delay, divert, or cancel flights.

When flights are delayed, the passenger trip for this segment is also delayed for the duration of the flight delay. When flights are cancelled or diverted, or passengers are bumped for overbooking, the passenger trip delay includes the duration of delay accrued waiting for the re-booked flight. All of these delays represent passenger trip delays.

Previous research by Bratu & Barnhart [2005] identified the discrepancy between flight performance and passenger trip performance. Wang [2007] showed that the 2% of passengers experiencing cancelled flights accrued delays of approximately 10 hours each, and that the total delays experienced by these passengers accounted for 40% of the total passenger trip delays.

This research provides the results of analysis of the U.S. air transportation system in 2007. The results are summarized as follows:

1. Passengers experienced a total of 247 Million hours of delays. The average delay was 24.3 minutes. Flights delayed 15 minutes or more accounted for 48% of the total delays, cancelled flight 43%, diverted flights 3%, and flights delayed less than 15 minutes accounted for almost all the remaining 6%. Passenger trip delays for overbooked passengers were less than 1%.

2. For flights on the 5224 routes between 309 airports, 50% of the routes experience an average passenger trip delay less than 15 minutes. 90% of the routes experience an average trip delay of less than 30 minutes.

3. For flights inbound and outbound of the 309 airports, 40% of the airports experience an average passenger trip delay of less than 15 minutes, 90% less than 30 minutes. Poorly performing airports included major hub airports as well as small commuter airports.

4. Passenger trip delay exhibited similar performance on routes of different stage-lengths[1].

The paper is organized as follows: Section 2 provides a summary of previous research. Section 3 describes the

[1] Stage-length is the *great-circle* distance of a flight.

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algorithm and database structure used to compute estimates of passenger trip delay in 2007. Section 4 describes the results of the analysis. Section 5, Conclusions, discusses the implications of these results.

II. Previous Research

Researchers have shown that flight-based metrics, like the metrics reported in the Department of Transportation's Airline Travel Consumer Reports (ATCR) [DOT, 2007] are a poor proxy for passenger experience [Wang, Schaefer, Wojik, 2003; Mukherjee, Ball, Subramanian, 2006; Ball et al., 2006; Bratu & Barnhart, 2005]. Bratu & Barnhart [2005] used proprietary airline data to study passenger trip times from a hub of a major U.S. airline.

This study showed that that flight-based metrics are poor surrogates for passenger delays for hub-and-spoke airlines as they do not capture the effect of missed connections, and flight cancellations. For example, for a 10 day period in August 2000, Bratu & Barnhart [2005] cite that 85.7% of passengers that are not disrupted by missed connections and cancelled flights arrive within one hour of their scheduled arrival time and experience an average delay of 16 minutes. This is roughly equivalent to the average flight delay of 15.4 minutes for this period. In contrast, the 14.3% of the passengers that are disrupted by missed connections or cancelled flights experienced an average delay of 303 minutes.

Wang [2007], Sherry, Wang & Donohue [2006] developed an algorithm to estimate passenger trip delay for publicly available data from the Bureau of Transportation Statistics (http://www.bts.gov). One part of the algorithm joins separate databases with secondary data to derive the parameters to perform the passenger trip delay analysis. The next part of the algorithm computes an estimate of passenger trip delay for each scheduled flight. Key among those parameters used in the algorithm is the Passenger Load Factor for a flight. This algorithm uses the quarterly average Passenger Load Factor for flights on a given route. This results in undercounting for peak operations, and possible overcounting for non-peak operations. Further this analysis accounts for flight delays and cancelled flights only for routes between the OEP-35 airports.

The main results of this analysis are that passenger trip delays are disproportionately generated by cancelled flights. Passengers scheduled on cancelled flights represent 3 percent of total enplanements, but generated 45 percent of total passenger trip delay.

On average, passengers scheduled on cancelled flights experienced 607 minutes delay, and passengers who missed the

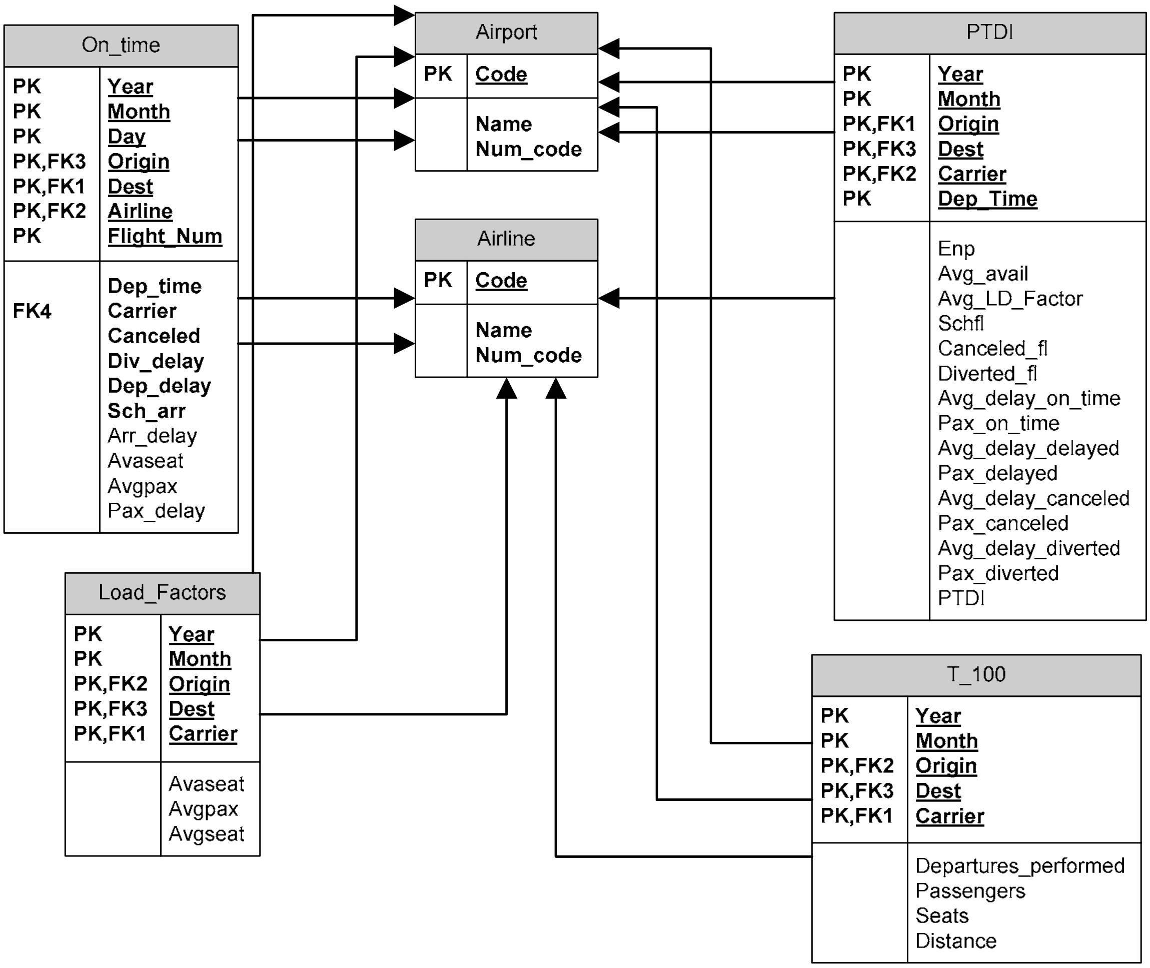

Figure 1. ER diagram of the local database

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connections experienced 341 minutes delay in 2006.

The analysis described in this paper improved the algorithm by increasing the pre-processing of data to eliminate infeasible data and check for referential integrity. Further improvements were made to the algorithm to include diverted flights, improve processing throughput and automating manual steps in the processing.

III. DATABASE AND ALGORITHM

A. The local database

A local relational database stores data imported from public databases. The data consist of actual flight and performance values collected by competent institutions. Being as massive as they are, the raw data contain errors. Because of that, the database includes constraints to improve the quality of the input data. The design of the local database is illustrated by an ER diagram as shown in Fig. 1; it consists of six entities and thirteen integrity and referential constraints. Since the data are time dependent all several entities identify the tuples using year and month among other attributes. Other attributes that identify tuples in the entities are the carrier or airline, and the route (composed of one origin airport and one destination airport).

The Airport and Airline entities make sure that the other entities contain only known airports and airline codes: all of the other entities have foreign keys referring to Airport and Airline.

The *On_Time* entity contains the data about each individual flight. In particular, the attribute *canceled*, if its value is one, indicates that the flight was canceled (a value of one).; otherwise, its value is zero. The attribute *div_delay* is either 0 for not diverted flights or 360 (min) for diverted flights. The attributes *avaseat* and *avgpax* are only used as temporal variables during the computation of *Estimated Passenger Trip Delay, EPTD* [Wang, 2007, Sherry, Wang & Donohue, 2006]. The attribute *pax_delay* (min) is the cumulated EPTD for all the passengers of the flight. Clearly, if *canceled* is 1, *div_delay* must be 0, and if *div_delay* is not 0, then *canceled* must be 0. The attributes *carrier* and *airline* are only different when the actual carrier is a subsidiary of an airline.

The *T_100* entity contains the input data concerning performance of pairs of route and carrier for domestic flights only. There are no data for individual flights. The entity includes information about the total number of departures done for a route and a carrier in the particular month (*departures_performed*), the total number of passengers transported (*passengers*), the total number of seats including all the flights (*seats*), and the distance of the particular route (in miles).

The entity *Load_factors* contains data derived from *T_100*. For a particular route and airline, the each record contains the average number of unoccupied (available) seats in the flights (*avaseat*), the average number of passengers per flight (*avgpax*), and the average number seats in the plane -the size of the plane- (*avgseat*). Clearly, the following conditions must be true at all times: $avgseat \geq avaseat$ and $avgseat \geq avgpax$.

The entity *PTDI* contains the result of the *Passenger Trip Delay Index* (*PTDI*) computation. In this case, flights are identified by their route, carrier, and departure time: no individual flights are recorded in this entity, but only averages of the flights that occur periodically at the given route, carrier, and departure time. The entity also includes data about the total number of *enplanements*[2] (*enp*), the average total number of seats available (*avg_avail*), the average load factor of this flight (*avg_LD_factor*), the number of scheduled flights (*schfl*), the number of canceled flights (*canceled_fl*), the number of diverted flights (*diverted_fl*), and the average delay time in minutes and number of passengers delayed for each category (canceled, diverted, delayed, and on-time) of flight. Finally, the entity also contains (though redundantly because it can be derived from the other attributes) the PTDI value in minutes. Notice that the delays can be zero, negative or positive real numbers. Negative numbers indicate that the passengers were not delayed but they arrived early. The number of enplanements must be greater than zero for the PTDI to make sense. The same happens with the number of scheduled flights. Clearly, the condition $canceled\_fl + diverted\_fl \leq Schfl$ must be true at all times.

B. Input data

The computation of the PTDI uses data from the Bureau of Transportation Statistics (BTS); particularly from two databases that are available on-line to download.

The first database is the T-100 for the domestic segment [BTS, 2006b]. This database allows the download of a whole year for all the carriers in the domestic (USA) segment. The fields selected to download are: year, month, origin, dest, carrier, seats, departures performed, passengers, carrier region, and distance. This experiment uses a single file containing data for the year 2007 from January to October[3]. The file contains 277870 records for 203 different carriers, 1142 airports[4], and 23507 routes. The process to compute load factors for the flights and distance information for the routes uses these values. Every record of this file must comply with the conditions states in Table I to enter the local database.

TABLE I. CONDITIONS FOR EACH RECORD OF THE T_100 DATABASE

Field	Condition
Year	Equal to 2007
Month	In range [1, 10]
Origin	The value must be already in the Airport table
Dest	The value must be already in the Airport table
Carrier	The value must be already in the Airline table
Seats	An integer number that is greater than or equal to Passengers
Departures performed	A positive integer number
Passengers	A positive integer number
Carrier region	Only the value "D" (for domestic) is accepted
Distance	A positive real number

[2] An enplanement is a transported passenger.
[3] November and December were not available at the time of the experiment.
[4] These data include airports in Puerto Rico, and airports in project that are being used already.

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A record that does not comply with all the conditions does not enter the local database, so that it is not used during the computation of the PTDIs. A total of 134111 records actually entered the local database including 932 airports, 115 carriers, and 17493 routes. Notice that some of the airports, carriers and routes are not actually referred in the On-Time database for the same period of time. These extra records in T_100 have no effect in the final results because the algorithm does not use them. The values for seats, passengers, and departures performed are monthly totals. There are no data for individual flights; therefore, average values are used in this experiment to approximate the actual values. The local database derives and stores the following values concerning load factors per year, month, route, and carrier:

- average number of seats, *avgseat* = *seats* / *departures performed*
- average number of passengers, *avgpax* = *passengers* / *departures performed*
- average number of available seats, *avaseat* = (*seats* – *passengers*) / *departures performed*

Therefore, the average load factor for a year, month, route, and carrier is: *lf* = *avgpax* / *avgseat*.

The second database is the so-called Airline On-Time Performance [BTS, 2006a]. This database allows the download of individual months of a particular year for all the airports and carriers in the USA. The fields selected to download are: flight_date, carrier, origin, dest, arr delay, crs arr time, dep delay, crs dep time, cancelled, diverted, fl_num, and tail_num. This experiment uses ten separate files for the year 2007, one for each month from January to October. Table II summarizes the figures for each one of the files.

TABLE II. STATISTICS FOR EACH OF THE ON-TIME INPUT FILES

Month	Records	Carriers	Airports	Routes
January	621555	20	289	4436
February	565602	20	288	4411
March	639209	20	288	4396
April	614648	20	289	4504
May	631609	20	294	4476
June	629280	20	298	4599
July	648542	20	300	4569
August	653276	20	298	4606
September	600186	20	298	4568
October	629990	20	292	4554
Total entered	6233873	17	309	5224

Notice that only 17 of the 20 carriers entered the local database. It is because the records with the three missing carriers did not comply with the conditions stated below. To enter the local database, each record must comply with the conditions stated in Table III.

TABLE III. CONDITIONS FOR EACH RECORD OF THE ON-TIME DATABASE

Field	Condition
Flight date	Any valid date for the year 2007
Origin	The value must be already in the Airport table
Dest	The value must be already in the Airport table
Carrier	The value must be already in the Airline table
Arrival delay	Any integer number (including 0 and negative ones).
Scheduled arrival time	A four digit positive integer number. The two left-most digits represent the hour in 24 hr format. The two right-most digits represent the minutes.
Departure delay	Any integer number (including 0 and negative ones).
Scheduled departure time	A four digit positive integer number. The two left-most digits represent the hour in 24 hr format. The two right-most digits represent the minutes.
Cancelled	Either 0 (not cancelled) or 1 (cancelled)
Diverted	Either 0 (not diverted) or 360 (6 hrs in minutes)
Flight number	Any value, but usually a three or four digit integer number.
Tail number	Any value. Used only to filter invalid records.

Each record must be unique with respect to flight date, origin, destination, carrier, and flight number. If there are repeated records, only one of them enters the local database. When the repeated records show differences in other fields, the user decides which one to keep. For instance, one of the records states that the flight was delayed and the other, that it was cancelled. The cancelled flight enters the local database in this case. Situations like this are not frequent: for the current input data only 53 records were repeated.

C. The algorithm

At a very high level of abstraction the algorithm to compute the PTDI is as follows:

- Import the T_100 data into the local database. This implies the computation of the load factor-related values.
- Import the on-time data into the local database. This implies the consideration of the carrier / subsidiaries relations. This means that subsidiaries are changed to their “parent” carrier every time they appear.
- Compute the EPTD based on the local load factor values and the local on-time data. This is done flight-by-flight, one month at a time. Fig. 2 illustrates the computation process of the EPTD.
- Compute the PTDI based on the EPTD, the delay, cancellation, and diversion data.

The following formulas compute the EPTD for each category of passengers:

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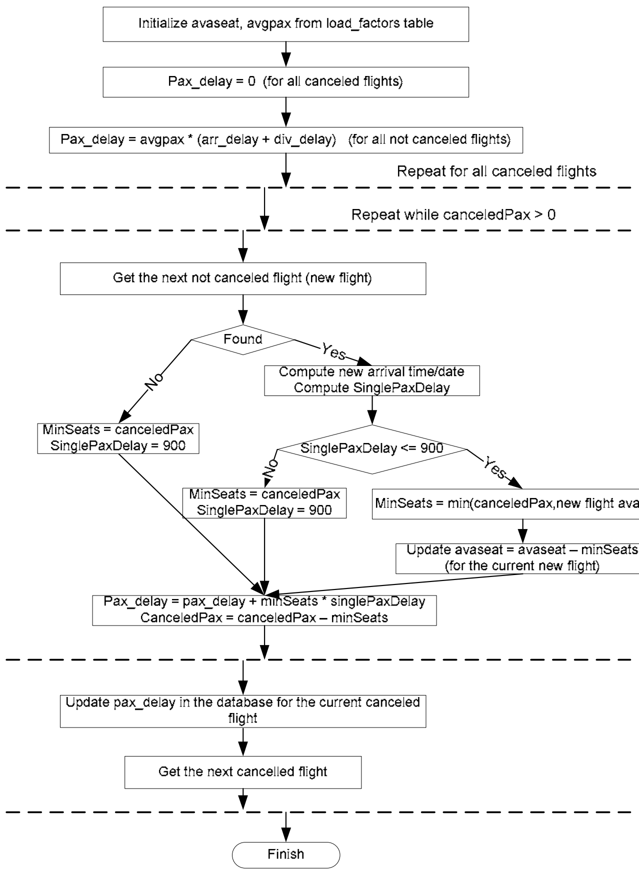

Figure 2. Algorithm to compute the EPTD

$$EPTD_{on-time}(f) = Pax(f) * ArrDelay_{<15}(f)$$
$$EPTD_{delayed}(f) = Pax(f) * ArrDelay_{\geq 15}(f)$$
$$EPTD_{cancelled}(f) = \sum_j Pax(f, j) * \max(15*60, SchArr(j) - SchArr(f) + ArrDelay(j))$$
$$EPTD_{diverted}(f) = Pax(f) * 6 * 60$$

Where Pax(*f*) is the number of passenger in the flight *f*. Pax(*f*, *j*) is the number of passenger from flight *f*, that were reloaded on flight *j*. $ArrDelay_{<15}(f)$ is the arrival delay of flight *f* (in minutes) when it is less than 15 minutes (flight arrives on-time). $ArrDelay_{\geq 15}(f)$ is the arrival delay of flight *f* (in minutes) when it is delayed (15 minutes or more delay). SchArr(*f*) is the scheduled arrival time of flight *f*. The constant 15*60 represents the maximum wait time (assumed) the passengers will tolerate before changing to another airline or transportation means, it equals 15 hours (in minutes). The constant 6 * 60 is the estimated delay time for a diverted flight; it equals 6 hours (in minutes).

At a high level of abstraction, the computation of the PTDI consists of eight steps:

- Compute the passenger delay for on-time flights: those arriving early or up to 15 minutes after the scheduled arrival time[5].
- Compute the passenger delay for delayed flights: those arriving 15 or more minutes after the scheduled arrival time.
- Compute the passenger delay for canceled flights.
- Compute the passenger delay for diverted flights.
- Compute the number of enplanements.
- Compute the PTDI-related load factors.
- Eliminate null values (if any) and merge flights that depart less than 40 minutes after another flight of the same carrier on the same route.
- Compute the PTDI. Fig. 3 illustrates the computation process of the PTDI.

The following formula computes the PTDI:

$$PTDI_{r,a,t} = \frac{\sum_{r,a,t} Pax_{on-time}}{\sum_{r,a,t} Pax} * EPTD^{r,a,t}_{on-time} + \frac{\sum_{r,a,t} Pax_{delayed}}{\sum_{r,a,t} Pax} * EPTD^{r,a,t}_{delayed} + \frac{\sum_{r,a,t} Pax_{canceled}}{\sum_{r,a,t} Pax} * EPTD^{r,a,t}_{canceled} + \frac{\sum_{r,a,t} Pax_{diverted}}{\sum_{r,a,t} Pax} * EPTD^{r,a,t}_{diverted}$$

Where $Pax_{on-time}$ is the number of passenger on-time (less than 15 minutes delay), $Pax_{delayed}$ is the number of passengers delayed, $Pax_{canceled}$ is the number of passengers in canceled flights, and $Pax_{diverted}$ is the number of passengers in diverted flights. Notice that the summations are performed after grouping the flights by route (*r*), airline (*a*), and departure time (*t*). Corresponding definitions are valid for the EPTD. Sub or superscripts *r*,*a*,*t* indicate that the associated values correspond to the average EPTD for the category (on-time, delayed, canceled, diverted) after grouping by route, airline, and departure time.

[5] The convention is that flights arriving with less then 15 minutes of delay are on-time.

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IV. RESULTS

The following analysis was conducted for 2007 for the months January through October using data derived from the BTS database for those months and year. The data included 512.8M passengers on 6.2 million flights on 5224 routes between 309 airports. The passenger trip delay includes an estimate of the total number of delay hours for on-time, delayed, cancelled, and diverted flights.

- Estimated total passenger trip was 247.08M hours. The average trip delay was 24.33 minutes.
- Estimated total passenger trip delay for passengers on flights delayed more than 15 minutes 119.44 M hours. The average trip delay for these passengers was 56.19 minutes.
- Estimated total passenger trip delay for passengers on cancelled flights was 107.39M hours. The average trip delay for these passengers was 667.93 minutes.
- Estimated total passenger trip delay for passengers on diverted flights was 7.77 M hours. The average trip delay for these passengers was 360 minutes.
- Estimated for passenger trip delay for over-booked passengers was negligible.

A. Comparison of flight delay and passenger delay

Fig. 4 shows a graphical comparison of flight delay and passenger trip delay (PTD). The y axis of the chart shows percentage of the total delay hours. The categories included are delayed, cancelled, and diverted flights. Flights that arrived early or with less than 15 minutes of delay are not included in the chart: they are considered on-time. Because of these on-time flights, the bars do not add to 100%. In other words, the on-time flights can also generate delays, but they are low enough to consider them as negligible.

The total delay measured using flight delay is 1.63 million hours as indicated in the chart. Notice that the flight delay metric does not consider canceled flights because those flights do not incur in delays.

On the other hand, the total delay measured using PTD is 240.08 million hours. This amount is very different from the 1.63 million of the other metric. In this case the total also considers the delays due to canceled flights, and not only diverted and delayed flights.

The PTD metric is more detailed and faithful to the real situation: passengers from a canceled flight experience considerable delays. In fact, the delays for passenger from canceled flights amount for about 43% of the total delay. About 48% of the total delay is due to delayed flights, and the rest of the delay is distributed among diverted and on-time flights.

B. Comparison of routes

Fig. 5 compares the histograms and cumulative distributions of the average PTDI and the maximum PTDI for all the routes with respect to the delay ranges (15 minutes each range). Form the point of view of the average PTDI, 50% of the routes show on-time flights; and 90% of them show flights that are delayed less than 30 minutes. In extreme situations (maximum PTDI) about 20% of the routes show on-time flights and 50% show flights delayed 30 minutes or less. This distribution shows a peak not at the 0-15 minute range as the one for the average PTDI, but at the 30-45 minutes range. After the peak, the distribution descends monotonically slower than it the distribution of the average PTDI.

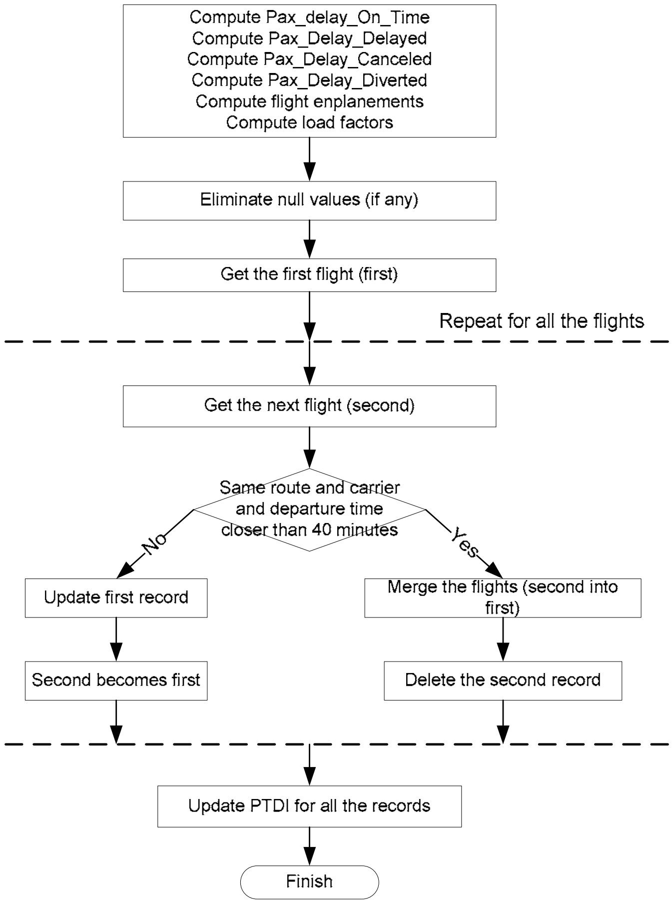

Figure 3. Algorithm to compute the PTDI

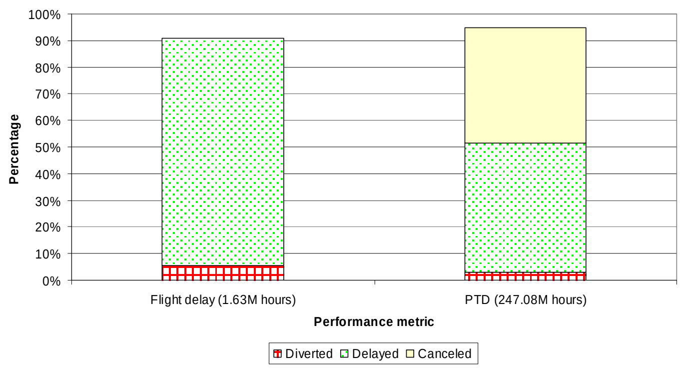

Figure 4. Comparison of flight delay and passenger delay as performance metrics

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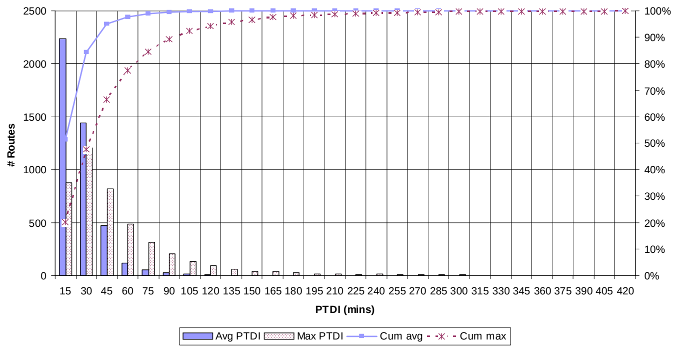

Figure 5. Distribution of routes with respect to the delay range

Comparison of route distance

The distribution of routes is similar for each distance range as shown in Fig. 6. Notice that the distance ranges are given in nautical miles (nm). All the ranges show between 55 and 47 percent of on-time routes. Between 29 and 38 percent of the routes show delays of 15 to 30 minutes. For the delay of 45 minutes the percentages are between 8 and 12. For the other distance ranges the behavior is also similar though with smaller percentage values. Though the differences are not big (8% at most), shorter routes tend to perform better: most of the routes of 500 nm and less are on-time (delay smaller than 15 minutes). Longer routes tend to delay more often. A significant part of the routes longer then 500 nm delay 30 minutes.

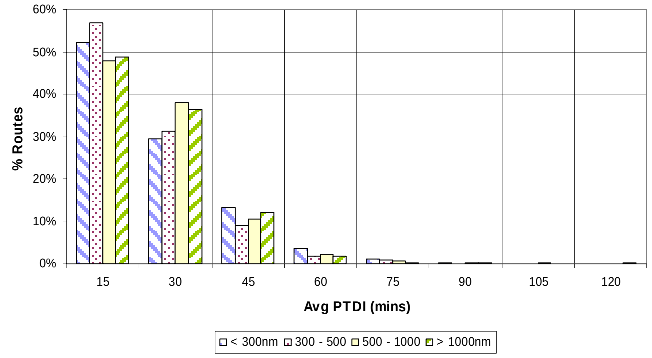

Figure 6. Percentage of routes grouped by distance per delay range

The informal comparison of the distribution of delays across distance ranges shows that the distribution has the same shape for all the distance ranges as shown in Fig. 7. In all the cases most of the flights are on-time and then the number of delayed flights decreases with each increase in the delay range. But, this chart also says that for shorter routes, is less probable to have long delay than it is for longer routes. For instance, the ratio of on-time to 30 minutes delay is about 17/10 = 1.7 for routes of 300 nm or less, but it is 31/24.5 = 1.2 for routes of 500 to 1000 nm.

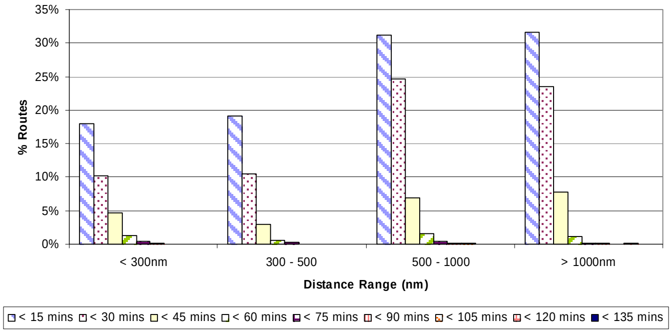

Figure 7. Percentage of routes grouped by distance range and delay range

C. *Comparison of airports*

The next step after comparing the routes is the comparison of the airports. In the case of inbound airports, Fig. 8 shows that most of them receive flights on-time or with 30 minutes

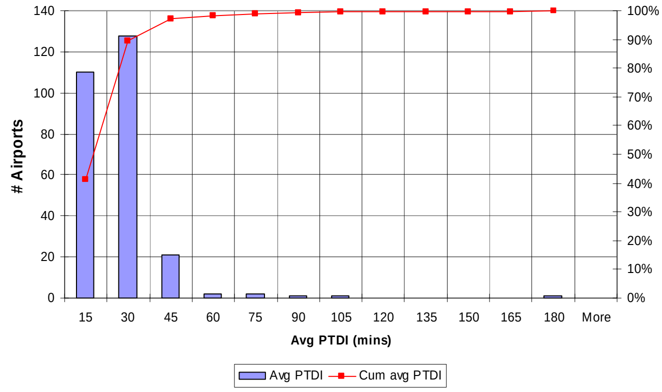

Figure 8. Inbound airport performance

delays: 40% of the airports show on-time flights, and 90% show delays of 30 minutes or less. Only few airports show average delays of 45 minutes or longer.

Table 4 summarizes a ranking of all the inbound airports in the database with respect to the average delay.

TABLE IV. BEST AND WORST INBOUND AIRPORTS RANKED ACCORDING TO PTDI

Best		Worst	
Rank	*Airport (delay)*	*Rank*	*Airport (delay)*
1	Greenville, MS	**202**	**PHL (23)**
2	Hilo, HN	**226**	**IAD (26)**
3	Pocatello, ID	**239**	**DFW (31)**
22	**HNL**	**241**	**EWR (31)**
31	**SJC**	**245**	**LGA (33)**
35	**HOU**	**248**	**ORD (33)**
39	**OAK (10)**	**255**	**JFK (37)**
40	**MDW (10)**	268	Meridian Regional (95)
59	**LAS (11)**	269	Rhinelander-Oneida (171)
61	**DAL (11)**		
75	**BWI (12)**		

This ranking is based on the average PTDI for the airport. Rank ties are possible as shown in the table. Airports in bold belong to the OEP-35. Notice that some of the OEP-35

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airports are ranked among the 75 best ones with respect the PTDI values.

The outbound airports behave as the inbound ones with respect to PTDI (see Fig. 9). About 90% the of the airports show delays of 30 minutes or less, and 40% show delays of 15 minutes or less. Again, only few airports show average delays of 45 minutes or more.

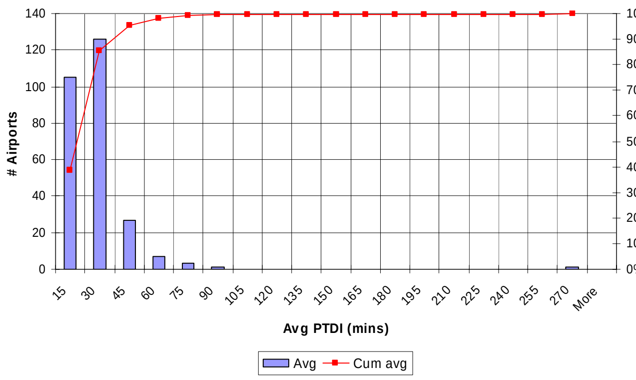

Figure 9. Outbound airport performance

Table 5 summarizes the ranking of all the outbound airports with respect to the average PTDI.

TABLE V. BEST AND WORST OUTBOUND AIRPORTS RANKED ACCORDING TO PTDI

Best		Worst	
Rank	*Airport (delay)*	*Rank*	*Airport (delay)*
1	Bristol/Johnson, TN	**194**	**PHL (23)**
2	Pocatello, ID	**214**	**IAD (26)**
6	Greenville, MS	**229**	**EWR (29)**
25	**SJC**	**238**	**DFW (31)**
28	**HNL**	**239**	**ORD (32)**
36	**OAK (9)**	**248**	**LGA (34)**
38	**HOU (9)**	**249**	**JFK (35)**
42	**DAL (11)**	265	Rhinelander-Oneida (55)
53	**MDW (11)**	270	Middle GA Reg (260)
89	**BWI (13)**		
109	LAS (15)		

This ranking is based on the average PTDI for the airport. Rank ties are possible as shown in the table. Airports in bold belong to the OEP-35. Notice that some of the OEP-35 airports are ranked among the 89 best ones with respect the PTDI values.

D. Comparison of airlines

Finally, Table 6 summarizes the ranking of the airlines with respect to the average and maximum PTDI. Notice that in the case of average PTDI the difference is at most 27 minutes. In the case of the maximum PTDI, the difference is at most 700 minutes.

This ranking is based on either the average or the maximum PTDI for the airport as indicated in the column headings of the table. Rank ties are possible as shown in the table.

TABLE VI. AIRLINES RANKED BY PTDI

Average PTDI		Maximum PTDI	
Rank	*Airline (delay)*	*Rank*	*Airline (delay)*
1	**Hawaiin (5)**	**1**	**Alaska (50)**
2	**Aloha**	**2**	**Aloha**
3	**Southwest**	**3**	**Hawaiin**
4	**Frontier**	**4**	**Frontier**
5	**Air Tran**	**5**	**Southwest (200)**
6	**Continental**	**6**	**USAirways**
7	**Alaska**	**7**	**Air Tran**
8	ExpressJet (19)	**8**	**Continental (250)**
9	United (19)	9	JetBlue
10	SkyWest (19)	10	SkyWest
11	USAirways	11	United
12	Delta	12	ExpressJet
13	Northwest	13	Northwest/Airlink (291)
14	Northwest/Airlink	14	Mesa
15	Mesa	15	American
16	JetBlue	16	Delta
17	American (32)	17	Northwest (750)

V. CONCLUSIONS

Passenger trip delay is a critical performance metric for the airline transportation system. This metric assesses the performance of the true end-users of the system, and provides a measure of the true cost of delays.

Future research is planned to: (1) extend the algorithm to include lost luggage and refine the overbooked passenger algorithm, (2) add an algorithm to adjust the load factor for peak and non-peak periods, (3) continue to refine the automation of data retrieval and processing.

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