

Dallas-Fort Worth Airport (DFW)



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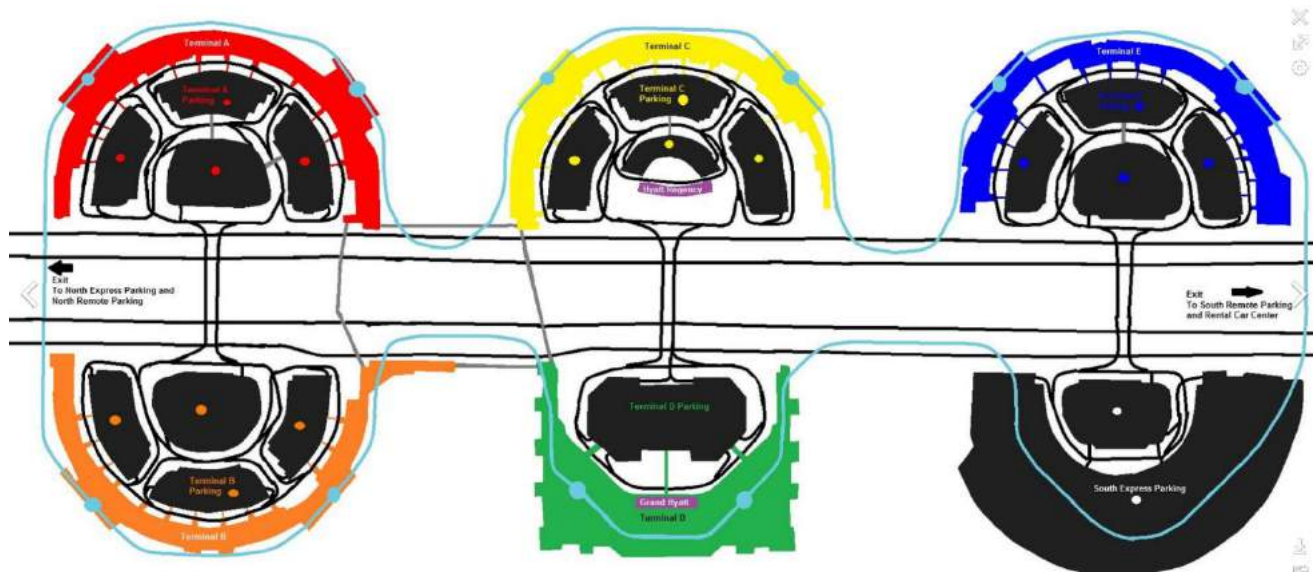
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History of DFW

The Dallas/Fort Worth International Airport served over 64 million passengers in 2015 and is the tenth busiest airport in the world by passenger traffic. Opening as Dallas/Fort Worth Regional Airport on January 13, 1974, the design and construction of the site took a little over two years with a price tag of \$700 million. It wasn't until 1985 when the airport changed its name to International, opening flights across the world. Originally built on four terminals, DFW now has five terminals (A, B, C, D, E) and 165 gates. Terminal D opened on July 23, 2005 which is why it has a square-like design unlike the U-shaped terminals of the other four. Figure 1 below shows the layout of the airport from north to south with its five terminals: A- red, B-orange, C-yellow, D-green, and E-blue. Terminal A is mostly occupied by American Airlines, which is headquartered only a few miles from DFW, and has 30 gates. Terminal B or "Terminal 2W" when the airport originally opened, sole operator is American Eagle. Prior to Terminal D's opening, this terminal operated all foreign flag carriers and until 2009 held United flights. Due to the new alliance and merger, United moved from B to Terminal E to join its newly acquired airline - Continental. Terminal C has 31 gates and houses American's MD-80s, some 767s, and their A319s. It also holds the Hyatt Regency directly adjacent to this terminal. Terminal D is the newest of the five terminals and is roughly 2 million square feet capable to handle 32,000 passengers daily. This terminal has both domestic and international flights with 30 gates. Finally, is Terminal E. Originally called 4E its primary operator was Delta. With 50 flights per day, Delta is the largest airline out of this terminal. In 2013 with recent renovations complete, Terminal E now houses flights for Spirit and US Airways, along with United and Alaska Air. This terminal has the most gates at 35 (Airport History, 2016).

Figure 1



History of TSA Security

Prior to the September 11, 2001 attacks, airport security was provided in the United States by private companies contracted by the airline or airport. In some countries, there was no or only random security checks. Identification was also not fully enforced. In response to the 9/11 attacks, the federal government created the Transportation Security Administration (TSA) which took over all the security functions of the Federal Aviation Administration (FAA), the airlines, and airports. Although the TSA doesn't just work for aviation security, a bulk of its employees work in this department. As of September 2014, the TSA employed 47,000 Transportation Security Officers (TSOs) (Transportation Security Administration, 2016). Such employees are those we hand our ID and boarding pass to and inspect our carryon luggage and personal belongings while passengers walk through a detection device prior to entering the airport's boarding zones. As most travelers are aware, this security change has increased airport travel time significantly. In response to long wait times and accommodate frequent flyers, the TSA created what we know as TSA PreCheck. TSA PreCheck is a yearly enrollment for eligible, low-risk travelers to enjoy expedited security screening. When a traveler is eligible for PreCheck, they no longer are required to remove shoes, laptops, or liquids. They can enter a separate security line from other travelers and per the TSA website, 97% of passengers with this eligibility waited less than 5 minutes in July at security (TSA Pre, 2016).

The DFW airport has 13 security checkpoints with 5 of them having TSA PreCheck as seen in Figure 2 (TSA Security Checkpoints, 2016). TSA PreCheck is only open during hours designated to the right. Therefore, eligible travelers flying outside of these times or flying out of Terminal B must go through normal security lines. Over the course of the last few decades, annual passenger traffic has increased from 25 million to 64 million as shown in Figure 3 (Dallas Fort Worth International Airport, 2016). This is an alarming 156% increase in airport traffic. In 2015, daily passengers exceeded 175,000. On average, each checkpoint must serve approximately 13,500 passengers daily or roughly 700 travelers per hour. As the DFW metroplex has increasingly grew over the past few years, airport congestion at security has required some passengers to arrive to the airport more than two hours in advance (with or without a checked bag). Therefore, this is the purpose of this study.

Figure 3



Figure 2

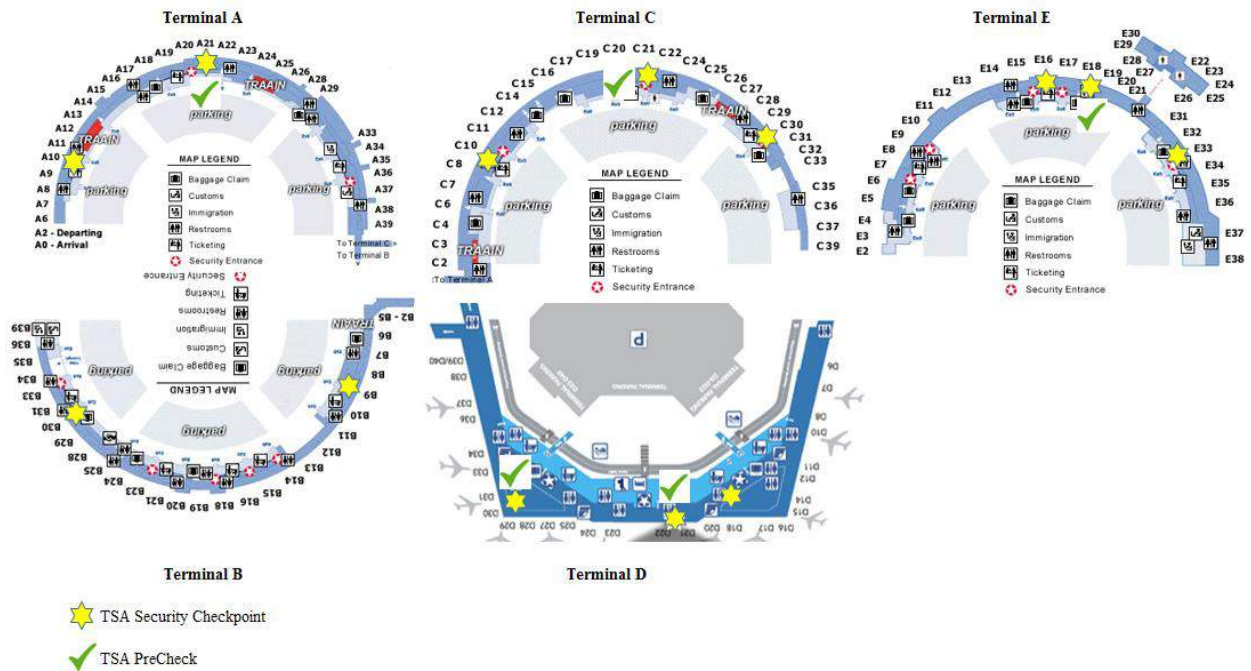
Terminal A	
A10	4:30 AM - 9:00 PM
A21	4:00 AM - 10:30 PM
A21 TSA Pre✓™	5:00 AM - 7:00 PM
Terminal B	
B9	4:30 AM - 10:45 PM
B30	4:30 AM - 9:00 PM
Terminal C	
C10	4:30 AM - 9:00 PM
C20 TSA Pre✓™	4:30 AM - 6:00 PM
C21	3:00 AM - 10:30 PM
C30	4:30 AM - 9:00 PM
Terminal D	
D18	4:15 AM - 10:00 PM
D22	5:00 AM - 9:00 PM
D22 TSA Pre✓™	hours vary during operation
D30	4:00 AM - 11:00 PM
D30 TSA Pre✓™	5:00 AM - 9:00 PM
Terminal E	
E16	3:45 AM - 8:45 PM
E18	3:45 AM - 11:30 PM
E18 TSA Pre✓™	4:00 AM - 6:00 PM
E33	4:00 AM - 8:30 PM
E33 CLEAR*	5:00 AM - 7:00 PM

Purpose of Study

The TSA security lines have been under intense scrutiny at the DFW airport since the beginning of this year. As of May 31, 2016, the D/FW International Airport's board had approved a contract with AT&T to study security wait times. American Airlines told NBC News that during spring break travel season this year, DFW had the second most passengers missing flight due to security congestion (Horne, 2016). Therefore, the purpose of this study is to analyze the passenger traffic at DFW's security checkpoints and propose improvements to reduce passenger wait times. We will analyze the facility layout and perform a load distance model to propose a new layout. In addition to layout planning, we will look at the TSA PreCheck locations and complete a waiting line model analysis to examine the need to add additional locations.

Facility Layout

Figure 4



Wait Times at DFW

In order to decrease wait times, we first need to establish a good metric for what wait times currently are at the various terminals and gates. In Figure 5, we see a snapshot of wait times taken on November 2, 2016 between 8am-12pm Central Standard Time (CST). The

following snapshot was taken from ifly.com who measured these wait times by leveraging flight volume data and TSA staffing models. According to iFly.com these are accurate up to 5 minutes.

Figure 5

	0-10 Min	11-20 Min			21+ Min
Terminal A Gates A17 - A27	08:00AM 10:30AM	08:30AM 11:00AM	09:00AM 11:30AM	09:30AM	10:00AM
Terminal A Gates A28 - A39	08:00AM 10:30AM	08:30AM 11:00AM	09:00AM 11:30AM	09:30AM	10:00AM
Terminal A Gates A6 - A16	08:00AM 10:30AM	08:30AM 11:00AM	09:00AM 11:30AM	09:30AM	10:00AM
Terminal B Gates B15- B28	08:00AM 10:30AM	08:30AM 11:00AM	09:00AM 11:30AM	09:30AM	10:00AM
Terminal B Gates B2- B14	08:00AM 10:30AM	08:30AM 11:00AM	09:00AM 11:30AM	09:30AM	10:00AM
Terminal B Gates B29- B39	08:00AM 10:30AM	08:30AM 11:00AM	09:00AM 11:30AM	09:30AM	10:00AM
Terminal C Gates C13 - C27	08:00AM 10:30AM	08:30AM 11:00AM	09:00AM 11:30AM	09:30AM	10:00AM
Terminal C Gates C2- C12	08:00AM 10:30AM	08:30AM 11:00AM	09:00AM 11:30AM	09:30AM	10:00AM
Terminal C Gates C28 - C39	08:00AM 10:30AM	08:30AM 11:00AM	09:00AM 11:30AM	09:30AM	10:00AM
Terminal D Gates D16 - D29	08:00AM 10:30AM	08:30AM 11:00AM	09:00AM 11:30AM	09:30AM	10:00AM
Terminal D Gates D30 - D40	08:00AM 10:30AM	08:30AM 11:00AM	09:00AM 11:30AM	09:30AM	10:00AM
Terminal D Gates D6 - D15	08:00AM 10:30AM	08:30AM 11:00AM	09:00AM 11:30AM	09:30AM	10:00AM
Terminal E Gates E12 - E30	08:00AM 10:30AM	08:30AM 11:00AM	09:00AM 11:30AM	09:30AM	10:00AM
Terminal E Gates E2 - E11	08:00AM 10:30AM	08:30AM 11:00AM	09:00AM 11:30AM	09:30AM	10:00AM
Terminal E Gates E31- E38	08:00AM 10:30AM	08:30AM 11:00AM	09:00AM 11:30AM	09:30AM	10:00AM

We have pulled one days' worth of data on a date in the middle of the week. Since one of the main principals of forecasting is that forecasting is more accurate for shorter time periods rather than longer ones, we chose to refine our method to a single day. We chose the date of November 2 to limit random variation or statistical anomalies such as holidays or weekends, and focused on the peak times of 8am to 8pm CST. After plotting the points we determined that the biggest terminals and gates with wait times consistently over 20 minutes are Terminal B29-B39. If we were to map these variables these gates would be out of our control limits, with a lower

limit of 0 and an Upper limit of 20 minutes. The entire breakdown of each terminal and gate by time and wait time is shown in figure 6 below.

Figure 6

Terminal and Gate	8:00 AM	8:30 AM	9:00 AM	9:30 AM	10:00 AM	10:30 AM	11:00 AM	11:30 AM	12:00 PM	12:30 PM	1:00 PM	1:30 PM	2:00 PM	2:30 PM	3:00 PM	3:30 PM	4:00 PM	4:30 PM	5:00 PM	5:30 PM	6:00 PM	6:30 PM	7:00 PM	7:30 PM	8:00 PM
A17-A27 Wait Times	Yellow	Green	Green	Yellow	Green	Yellow	Green	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Yellow	Yellow	Green	Green	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green
A28-A39 Wait Times	Green	Yellow	Green	Yellow	Yellow	Yellow	Green	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Yellow	Yellow	Green	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green	Green
A5-A16 Wait Times	Green	Green	Yellow	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
B15-B28 Wait Times	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
B2-B14 Wait Times	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
B29-B39 Wait Times	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
C15-C27 Wait Times	Yellow	Yellow	Yellow	Yellow	Green	Yellow	Green	Yellow	Green	Yellow	Green	Yellow	Yellow	Green	Yellow	Green	Yellow	Green	Green	Green	Green	Green	Green	Green	Green
C2-C12 Wait Times	Green	Green	Yellow	Green	Green	Green	Green	Green	Green	Yellow	Green	Yellow	Yellow	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
C28-C39 Wait Times	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
D16-D29 Wait Times	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Yellow	Green	Yellow	Yellow	Yellow	Yellow	Green	Yellow	Green	Yellow	Green
D30-D40 Wait Times	Yellow	Green	Yellow	Yellow	Yellow	Green	Green	Green	Yellow	Yellow	Yellow	Green	Yellow	Green	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Green	Green
D6-D15 Wait Times	Yellow	Yellow	Yellow	Yellow	Green	Yellow	Yellow	Yellow	Green	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow	Green	Yellow	Green	Green
E12-E30 Wait Times	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
E2-E11 Wait Times	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red	Red
E31-E38 Wait Times	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green

Key:
Green = 0-10 Minute Wait
Yellow = 11-20 Minute Wait
Red = 20+ Minute Wait

Now that we have the wait times, we can begin to forecast using a quantitative method to determine DFW’s strengths, and separate the gates and terminals from where their wait times are consistently over 20 minutes and the gates and terminals where DFW is more efficient. A good forecasting method for this is a naïve time series model, using the formula $F^{t+1} = A^t$. Using this naïve time series model, we could use the actual values observed above to identify historic patterns between terminals and gates moving more slowly to make recommendations such as spreading planes around to less impacted terminals and gates, and increasing TSA employees to gates and terminals where the wait is expected to be heavy. In addition, we could strengthen our forecasting by looking at the TSA Pre-Check Hours shown in figure 2. When comparing figure 2 with figure 6, we can use Causal models or Associative models to explore the cause and effect relationships that the Pre-Check Screening hours has on each terminal and gate. A possible tool for this would be linear regression, by using the formula $Y = a + bx$.

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