athena

Wisdom to guide mobility transformations at U.S. ports

Airport Surface Transportation Digital Twin Framework

Our combined demand forecasting and traffic microsimulation framework can help airports navigate operational challenges and plan for the future.

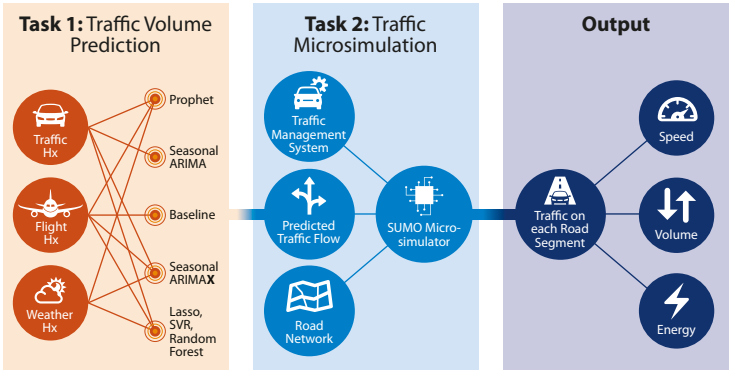
The Challenge

As air travel continues to grow, airports will face challenges with increasing passenger vehicle traffic that could lead to lower operational efficiency, poor air quality, and security concerns. Significant innovations could allow the movement of more people and goods faster, cheaper, and with greater convenience, but how do airport operations staff decide the right innovations and policies to adopt?

Our Approach

To help airports navigate operational challenges and plan for the future, the Athena research team developed a demonstration, data-driven operational model for the fourth-busiest airport in the world.[1]

Using two years of detailed data on individual vehicle arrivals and departures, aircraft movements, and weather at DFW Airport, the Athena research team evaluated prediction methods, including seasonal autoregressive integrated moving average (SARIMA), Prophet, supervised machine learning algorithms, and modern neural networks.



The digital twin framework combines volume prediction and microsimulation to evaluate scenario evaluation, real-time forecasting, and planning. Figure by Brittany Conrad, NREL

The model has two primary functions: 1) it utilizes timeseries forecasting methods to predict traffic demand at the DFW Airport curbside, and 2) it combines the resulting demand forecast with a traffic microsimulation framework to provide a complete picture of traffic and its consequences. This "digital twin" of the airport uses machine learning to simulate events that can reliably be predicted and model traffic congestion under new conditions.

In this example of policy exploration, high demand congestion scenarios are mitigated with a policy that re-routes traffic to a different terminal to avoid gridlock. Figure by Christopher Schwing, NREL

Results

Of the prediction methods, SARIMA proved to be the most effective at forecasting traffic in the next 30 minutes, while machine learning models with careful feature engineering offer the best prediction for longer periods. The accuracy indicates that these tuned algorithms are effective enough for understanding future demand. By combining a demand forecast model with a traffic microsimulation framework, the "digital twin" provides an accurate operational intelligence platform.

Impact

The "digital twin" intelligence platform can help airport operations staff explore policy changes, infrastructure expansion, and disruption scenarios. This is a valuable framework for airports like DFW Airport as they tackle daily operational challenges, explore the integration of emerging technology, and consider expansion of services long term.

For more information, visit **athena-mobility.org** or contact **athena.mobility@nrel.gov**.

[1] Monte Lunacek, Lindy Williams, Joseph Severino, Karen Ficenec, Juliette Ugirumurera, Matthew Eash, Yanbo Ge, Caleb Phillips. "A Data-driven Operational Model for Traffic at Dallas Fort-Worth International Airport." 99th TRB Annual Meeting. January 12-16, 2020.

Photos by Dennis Schroeder, NREL.

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