

# DRISI

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INNOVATION AND SYSTEM INFORMATION

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# Research

# Results

Modal

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Aeronautics Research Support

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## Centrally Coordinated Schedules and Routes of Airport Shuttles with Los Angeles Airport (LAX) Terminals as Application Area

Develop a CENTrally COordinated Shuttle system (CENCOS) to effectively coordinate shuttle schedules and routes to minimize curb congestion at the pick-up and drop-off points.

### WHAT WAS THE NEED?

A critical problem facing United States airports as they respond to growth in services and operations is the limitation of curbside parking for shuttles to pick up and drop off passengers during peak hours. Today, shuttle companies and airport operations work independently without any schedule coordination, leading to frequent congestion near the pick-up and drop-off points that negatively affects passenger traffic leading to unnecessary idling, delays, and congestion with a negative impact on air quality and quality of service to passengers. Accurate prediction of arrival times at the pick-up and drop-off points depends on traffic conditions, which are time-varying, and on the schedules of other shuttles sharing the same curbside spots. Without any form of central coordination, a single shuttle company cannot accurately develop a schedule that maintains a high quality of service at a reduced operational cost. This problem is exacerbated by existing and growing shuttle services provided by the airports themselves, centralized car rental facilities, and public transportation hubs. Furthermore, the transition from conventional shuttles to electric ones and the possibility of autonomous shuttles add additional complexities that necessitate using a centralized shuttle coordination system for optimum performance.

### WHAT WAS OUR GOAL?

The goal was to develop a CENTrally COordinated Shuttle system (CENCOS) that can effectively coordinate shuttle schedules and routes to minimize curb congestion at the pick-up and drop-off points, reduce operational costs, improve quality of service with considerable benefits to mobility and the environment. Such a system should also support emerging technology trends, including burgeoning electrification and automation. CENCOS was



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designed using a co-simulation load balancing approach where the digital twin of the traffic network is part of the optimization procedure to take into account complex traffic dynamics and interactions of vehicles and generate accurate predictions of traffic states at the various links to be used by the optimizer. The system receives demands and desired schedules from all shuttle companies and generate schedules and routes that minimize an overall system cost while meeting the performance and operational cost goals of each shuttle provider.

## WHAT DID WE DO?

The researchers studied the Los Angeles (LAX) terminals and collected all information regarding shuttles serving the airport as well as relevant traffic data and updated the digital twin of the LAX traffic developed by the Principal Investigator (PI) in 2018 with the support of Los Angeles World Airports (LAWA). They developed the CENCOS system based on a co-simulation optimization approach for scheduling the airport shuttles of different companies serving the airport to minimize cost due to delays, energy consumption, and congestion at the curbside where the pick-up and drop-off points are located while improving the quality of service. They also incorporated electric and automated shuttles in the CENCOS system and evaluated cost and energy savings and benefits to the environment as the percentage of electric shuttles increases for each shuttle company. The researchers incorporated automated shuttles on fixed routes in the CENCOS system and evaluated the impact on the overall cost and performance.

The researchers used Monte Carlo microscopic traffic simulations integrated with the United States Environmental Protection Agency (EPA) Motor Vehicle Emission Simulator (MOVES) to quantify benefits to congestion, environment, and operational cost benefits. The design, analysis, and evaluation results with LAX as an example are presented in the final report with conclusions and directions for future steps.

## WHAT WAS THE OUTCOME?

The main outcomes of the project are listed as follows:

- The shuttles spend less waiting and traveling time in the airport area by participating in the proposed CENCOS system.
- The benefits generated by the CENCOS system depend on the background traffic and increase with heavy traffic.
- The CENCOS system shows savings in total cost of about 30% when compared with current shuttle management systems where each shuttle company operates individually without any coordination.
- The total cost of shuttle assignment from the CENCOS system decreases as the number of electric vehicles increases.
- The emissions go down drastically as the number of electric vehicles increases in the fleet.

The research performed was a preliminary step toward a coordinated shuttle scheduling and routing system using load balancing techniques and by no means captures the full complexity of shuttle transport. Some of the assumptions made need to be validated with experiments and some of the scenarios tested are rather simple when compared with the complexity of shuttle operations. This research however sets the foundations of the concept of centrally coordinated shuttle management systems by solving some challenging problems whose solutions point to the direction of future research for eventual implementation.

## WHAT IS THE BENEFIT?

The project falls under the area of mobility. A centrally coordinated airport shuttle system is expected to reduce congestion at the pick-up and drop-off locations at airport curbs and transportation hubs, with significant benefits to the environment and fuel economy. A well-operated airport shuttle system with accurate

schedules will lead to less traffic at congested airport lanes during peak hours. Incorporating and analyzing new technologies, such as electric and autonomous shuttles, and quantifying their benefits to operational costs and the environment is also very relevant to mobility in general. Airports such as LAX generate a lot of traffic and congestion at the airport lanes that will affect traffic in arterial streets and highways feeding and accepting traffic from the airport.

**LEARN MORE**

The final report is posted to this website when available:  
<https://dot.ca.gov/programs/research-innovation-system-information/research-final-reports>

UC Davis Direct Report link  
<https://escholarship.org/uc/item/6gg7r6c5>

**IMAGES**

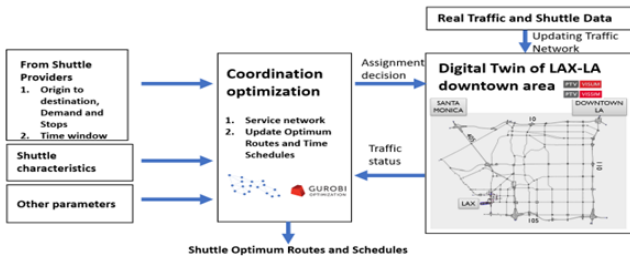


Image 1: Centrally Coordinated Shuttle System (CENCOS) for LAX

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